



4th International Symposium

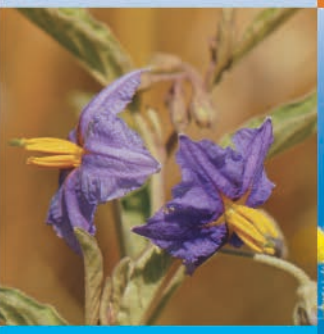
Environmental Weeds and Invasive Plants

May 19th to 23rd, 2014

Montpellier SupAgro, Montpellier, France

Program - Abstracts

List of participants









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Abstracts

Sponsors

We thank all our sponsors for supporting us financially and technically, as well as for facilitating the attendance of several students and researchers. In fact they guaranteed the realization of this symposium in Montpellier:

- Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail **Anses**
- Association Française de Protection des Plantes **AFPP**
- Biotechnology and Biocontrol Agency **BBCA**
- Centre for Agricultural Bioscience International **CABI**
- Laboratoire d'excellence - Centre Méditerranéen de l'Environnement et de la Biodiversité **LabEx CeMEB**
- Commonwealth Scientific and Industrial Research Organisation **CSIRO**
- Centre de coopération internationale en recherche agronomique pour le développement **Cirad**
- Direction Régionale de l'Agriculture, de l'Agroalimentaire et de la Forêt du Languedoc-Roussillon, **DRAAF LR**
- Ecophyto, Réduire et améliorer l'utilisation des phytos
- European and Mediterranean Plant Protection Organization **EPPO**
- European Weed Research Society – **EWRS** Working Group on Invasive Plants
- European Weed Research Society – **EWRS** Working Group on Biological control
- Food and Agriculture Organization of the United Nations **FAO**
- Mairie d'Allex
- Montpellier SupAgro
- Office national de l'eau et des milieux aquatiques **Onema**
- Région Languedoc-Roussillon
- Société Botanique de France **SBF**
- United States Department of Agriculture, European Biological Control Laboratory **USDA-EBCL**

Other supporting institutions

We also would like to thank several local institutions that helped us in different way by promoting the Symposium or by welcoming us for the two field trips of Wednesday 21st May

- Cave Coopérative de Montpeyroux
- Commune de Celles
- Commune du Grau-du-Roi
- Conseil Général de l'Hérault
- Conservatoire d'Espaces Naturels Languedoc-Roussillon & projet LIFE+LAG'Nature
- Conservatoire du Littoral
- Grand Site de France : Saint-Guilhem-le-Désert / Gorges de l'Hérault
- Office national de la Chasse et de la Faune Sauvage, Délégation Inter-Régionale Auvergne/ Languedoc-Roussillon
- Qualiméditerranée
- Syndicat mixte 'Grand Site du Salagou et Mourèze'
- Syndicat mixte pour la gestion et la protection de la Camargue gardoise
- Tela-Botanica
- Tour du Valat

Foreword

It happened around ten years ago that the European Weed Research Society (EWRS) intended to form a working group on invasive plants. One of the goals of this new group is *to assist communication* and information exchange between agricultural and environmental researchers; no need to repeat research in the field of invasive plants being done by others. The first event organized in 2006 was the 'International Symposium Intractable Weeds and Plant Invaders' on the Azores with an important contribution on *'Jumping the fenceline'* – how weed scientists and conservation biologists can work together towards solving weed problems. 2008 in Croatia we were talking about the influence of *landscape fragmentation and dispersal ability* on the early stages of a plant invasion – as well as the ecology of invasive weeds and implications for their control. In Switzerland 2011 a session was named "How far are *control methods transferable between agricultural weeds and plant invaders*". The last session on "Impacts to and *answers from human society* versus plant invasions" was opened by a discussion on the perception and management of invasive plants between environmental and social changes.

The EWRS WG on Invasive Plants is proud to continue discussing on these subjects here in Montpellier.

In 2011, a few people had this crazy idea to accept organizing the next *4th International Symposium on Weeds and Invasive Plants* in Montpellier, *and here we are now*! Organizing the 4th edition in Montpellier has partly determined the scientific program. Montpellier is located in the Mediterranean region which is known as one of the most *important biodiversity hotspots* in the world. In this region, the impact of invasive plants can be particularly dramatic in some vulnerable habitats (e.g., dunes, rocky cliffs and shores, salt marshes) including many threatened species. *Crop production* can be compromised by particularly intractable weeds like *Silverleaf nightshade* which can serve as an example to better organize regional management and cooperation across both sides of the Mediterranean Sea. All this is a good reason for a specific session dedicated to the *invasive plants in Mediterranean regions* which could also be considered as a bridge between the 2nd International Workshop on Invasive Plants in the Mediterranean Type Regions of the World held in Trabzon in Turkey in 2010 and the next edition to be held in Tunisia in 2015.

Two international research *teams based in Montpellier* (Csiro, USDA) are working on biological control of invasive plants, which was a good occasion to share their experience and focus on sustainable ways of managing invasive plants and more generally on integrated control methods. This is particularly so given the fact that alternative methods to chemical control are also encouraged in France through the *Ecophyto program* of the Ministry of Agriculture.

Several other co-organizing institutions (Anses, FCBN, French Ministry of Agriculture) play a major role in risk assessments, monitoring and surveillance of invasive plants. Proposing a new session on methods of *risk assessment* and priorization as well as early detection was found to be appropriate since these young fields of applied research will take a lot of importance in the framework of the new *European Union regulation* on Invasive Alien Species.

Last but not least, we keep alive three sessions that have confirmed their importance over the previous editions: the now classical session on *common ragweed* is this time co-organized by the COST Smarter (Sustainable Management of *Ambrosia artemisiifolia* in Europe) project. No need to justify a specific focus *on aquatic and riparian habitats* which are among the most affected by biological invasions with spectacular plants covering thousands square meters of ponds, lakes, etc. Finally, the success of control and eradication programs greatly depends *on how the general public view* biological invasions and accept the idea of management. Therefore, we found crucial to develop and strengthen social and economical aspects with a particular emphasis on how to communicate on invasive plants.

The conference takes place at *Montpellier SupAgro*, which has a long history in teaching and research in agronomy, ecology and plant sciences. It is worth noting that management of invasive species is strongly associated to this agronomic school since its creation in 1869. At the beginning of its history, SupAgro owes its reputation to the success won by teaching teams in the fight against the *scourge of phylloxera* in the years 1870-1890. In such an environment, *bursting with biological invasion science history*, the overall objectives of the week will be to *share our experiences* on the biology, ecology and management of invasive plants.

Invasive plants are now and in near future more and more *subject to interdisciplinary discussions and activities*. This is why we believe it is important to continue the events on weeds (agricultural/environmental) and invasive plants (intractable weeds). Weed research and control do not stick to chemical control only; herbicides find their place in agricultural mass production, but we know more tools for controlling plants. Still much work has to be done for *jumping the fenceline*, for describing invasive plants problems under *geographical influence*, for *exchanging experiences on control methods* and for a discussion on *answers from human society* versus plant invasions.

We look forward to the next edition of this event!

Remember also that *Symposium* comes from the Greek *συμποσιον* meaning 'banquet', therefore we also wish that you take the opportunity to enjoy some good times during the different social events of this meeting!

Christian Bohren (Agroscope, Switzerland), Chair of the EWRS Working Group on Invasive Plants
Guillaume Fried (Anses, France), Coordinator of the Organizing Committee

N.B.: The circle symbolizes the life cycle of a plant (colors of *Solidago* ssp.); the arrow stands for an effective and environmentally conscious control of weeds and invasive plants.

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General information to participants

We welcome you to the 4th International Symposium on Environmental Weeds and Invasive plants (Intractable Weeds and Plants Invaders) and hope you will have an exciting conference, an amazing field trip and a pleasant stay in Montpellier and in the Languedoc-Roussillon region.

Catering

Coffee breaks, lunches (Monday, Tuesday, Thursday and Friday), the welcome reception (Wine & Cheese) and the conference dinner (Thursday) are included in your registration. Coffee breaks are served in the *Hall d'Honneur* in front of the Amphitheater Philippe Lamour where the conference takes place. Lunches are served in the restaurant (canteen) of Montpellier SupAgro.

Speakers

Speakers are kindly requested to contact the chairman of their session block in order to upload their presentation before the beginning of the session. A video projector and a PC will be at your disposal. Please note that you will not be allowed to present from your personal computer.

Posters

After your arrival at the registration desk please hang your poster for the entire duration of the conference. Each poster is assigned a number in the abstract book.
Authors are expected to be by their poster during poster sessions. Also, be prepared for a short (2-3 min) presentation during plenary (chairmen of each session are free to organize posters presentation in plenary). Posters must be removed by Friday May 23rd noon at the latest.

Conference dinner

A conference dinner will be organized Thursday May 22nd at the Château de Flaugergues. Built at the end of the XVII century, Flaugergues is one of the so-called 'Folies', built in the countryside around Montpellier. Planted in the heart of rural domains, they are surrounded by magnificent gardens. Departure time from Montpellier SupAgro and detailed program will be communicated during the daily session.

Field trips

Wednesday May 21st is devoted to the field trips. To join one of the two field trips (see pages 12-13), you need to be registered in advance. Excursions are planned from 8.00 (bus departure 8.30) until 19.00. We strongly advice you to take sunblock and mosquitos repellent with you during your trip.

Registration fees does not cover accommodation, meals, drinks and transport other than that provided as part of the Symposium program as well as optional sightseeing tours and excursions.

Time	Monday May 19th	Tuesday May 20th	Wednesday May 21st
8.30-9.00	**Welcome addresses**	**Office opens**	**Office opens**
9.00-11.00	**Session 1** **Invasive plants in Mediterranean regions** Keynote: Montserrat Vilà	**Session 3** **Biology, Ecology, Evolution and Impacts of invasive plants** Keynote: Sébastien Lavergne	**Departure by bus at Montpellier SupAgro (8.00)** **Field trip 1** **Camargue and Mediterranean coast** **Field trip 2** **Garrigues and vineyard** **Back at Montpellier SupAgro at about 19.00**
11.00-11.30	**Coffee break**	**Coffee break**	
11.30-12.50	**Session 1 (continued)**	**Session 3 (continued)**	
12.50-13.15	**Poster session 1**	**Poster session 3**	
13.15-14.30	**Lunch**	**Lunch**	
14.30-16.30	**Session 2** **Invasive plants in aquatic and riparian ecosystems** Keynote: Joe Caffrey	**Session 4** **Invasive plant management: biological and integrated control** Keynote: Massimo Cristofaro	
16.30-17.00	**Coffee break**	**Coffee break**	
17.00-18.20	**Session 2 (continued)**	**Session 4 (continued)**	
18.20-18.45	**(18.00)** **Poster session 2**	**Poster session 4**	
18.45-20.00	*Overseas Laboratories: Making a Success through international Relationships (USDA)* Chair: Daniel Strickman		
20.00	**Welcome reception** **Wine & Cheese**	***Café de la Biodiversité*** **Debate for the general public (*in French*)** Sarah Brunel (EPPO) Brasserie le Dôme, 2, avenue Georges Clémenceau, 34000 Montpellier	

Time	Thursday May 22nd	Friday May 23rd	
8.30-9.00	**Office opens**	**Office opens**	
9.00-11.00	**Session 5** **Ragweed, joint session with COST Action SMARTER (Sustainable Management of *Ambrosia artemisiifolia* in Europe)** Keynote: Urs Schaffner	**Session7** **New tools for Weed Risk Assessment (WRA) and for Early Detection and Rapid Responses (EDRR)** Keynote: Dane Panetta	
11.00-11.30	**Coffee break**	**Coffee break**	
11.30-12.50	**Session 5 (continued)**	**Session 7 (continued)**	
12.50-13.15	**(12.30)** **Poster session 5**	**Poster session 7**	
13.15-14.30	**Lunch**	**Lunch**	
14.30-16.30	**Session 6** **Human perceptions of biological invasions** Keynote : Vernon Heywood		
16.30-17.00	**Coffee break**		
17.00-18.20	**Session 6 (continued) & Session 7**		
18.20-18.45	**Poster session 6**		
18.45-20.00			
20.00	**Conference dinner Château de Flaugergues**		

Field trip 1: Camargue and Mediterranean coast

Organizers: Dominique Coutinot, Matthew Augé & Guillaume Fried

Program

8.30-9.30	**Departure from Montpellier (SupAgro) at 8.30 Montpellier SupAgro, travel to Saint-Laurent-d'Aigouze**
10.00-12.00	**Domaine du Petit-Saint-Jean, Saint-Laurent-d'Aigouze (Gard)** Guide: **Nicolas Beck (Tour du Valat)** Guided tour of the domain including several habitats: a summary of the Camargue! Fallow fields (formerly vineyards) with *Ambrosia psilostachya* DC. ; forests of stone pines (*Pinus pinea* L.) with its oldest known pine tree and its various orchids (*Epipactis* spp., *Limodorum abortivum* (L.) Sw.); sandy grasslands (old dunes) with *Erianthus ravennae* (L.) P.Beauv., *Teucrium dunense* Sennen, *Vulpia* spp., etc.; temporary pools with the European pond terrapins (turtle) *Emys orbicularis*; ponds with many birds; salt marshes locally called the *sansouïres*
12.00-13.30	**Picnic on the grass with our packed lunch at the Domain 'Petit-Saint-Jean'**
14.00-16.00	**Managing actions on invasive plants at the littoral** (following the LIFE+ LAG'Nature project), **Espiguette/Salonique, Grau-du-Roi (Gard)** Guides: **Benjamin Sirot (Conservatoire des Espaces Naturels du Languedoc-Roussillon), Lucie Labbé (Syndicat mixte pour la gestion et la protection de la Camargue gardoise)** - Mediterranean *Limonium* salt steppes with *Limonium girardianum* (Guss.) Fourr. (protected at the national level), *Artemisia caerulescens* subsp. *gallica* (Willd.) K.M.Perss., etc. - *Juncus maritimus* salt marshes with *Baccharis halimifolia* L. at the beginning of invasion stage.
16.00-18.00	Wine tasting at **Listel** (Wines of the Sand 'Sable-de-Camargue')
18.00-19.00	Expected return to Montpellier SupAgro at **19.00**

Field trip 2: Garrigues and vineyards

Organizers: René Sforza, Pierre Ehret, Isabelle Mandon-Dalger & Guillaume Fried

Program

8.30-9.30	**Departure from Montpellier (SupAgro) at 8.30, travel to the Salagou Lake**
9.30-11.30	**Salagou Lake** Guides: **P. Arnaud (ONCFS), J. Brémond (CG34), P. Martin (Association Mattoral)** Presentation of the ongoing eradication programme against *Opuntia rosea* DC. **(P. Arnaud)** Management actions against *Lagarosiphon major* (Ridl.) Moss and other aquatic invasive plants **(J. Brémond & P. Arnaud)** Geology, flora and fauna around the Salagou Lake **(P. Martin)**
11.30-15.30	**Montpeyroux, its vineyards, its garrigues and its *Castellas*** (11.30-12.30) **A botanical walk** between the hamlet Barry and the ruined castle (Castellas) to discover the **flora of the garrigues** (12.30-14.30) **Picnic** accompanied by a tasting of wines from Montpeyroux (14.30-15.30) Guided tour of the **vineyard** and/or the **cellar** Optional stop to see a small population of *Solanum eleagnifolium* Cav. under control
16.00-18.00	**Guided tour of Saint-Guilhem-le-Désert (1h) + possible stop at the Pont du Diable** (XIth century) with an early colonization by *Nassella tenuissima* (Trin.) Barkworth)
18.00-19.00	Expected return to Montpellier SupAgro at **19.00**

Monday, May 19th

Session 0	**Introduction: Welcome addresses** Chair: G. Fried & C. Bohren
8.30-8.40	EWRS (C. Bohren)
8.40-8.50	Montpellier SupAgro (M.L. Navas)
8.50-9.00	Organizing Committee (G. Fried)
Session 1	**Invasive plants in Mediterranean regions** Chair: J. Recasens, A. Taleb & G. Fried
9.00-9.40	**Ecological impacts of invasive plants** **Keynote: Montserrat Vilà**
9.40-10.00	Cacti as alien species: a global review Novoa, A.
10.00-10.20	The reed cane *Arundo donax* L., an ancient Mediterranean invasive species originating from Middle East Hardion, L.
10.20-10.40	Drier climatic conditions may lead to increased herbivore pressure on a native tree, but not on an invasive competitor Van der Colff, D.
10.40-11.00	A comparative study between the photoprotection strategies of an alien invasive species with a native protected Mediterranean palm Pintó-Marijuan, M.
11.00-11.30	**Coffee Break**
11.30-11.50	Heads and tails in *Acacia dealbata* Link management: effectiveness of control and implications for native plants and soil microbial function Souza-Alonso, P.
11.50-12.10	A comparative study of the life traits of alien versus native weeds of the crops of Oranie (North-West Algeria) Kazi Tani, C.
12.10-12.30	*Solanum elaeagnifolium* Cav. (Silverleaf Nightshade), a rising problem in the Mediterranean region Kashefi, J.
12.30-12.50	Are irrigated crops and the surrounding riparian habitats linked by alien weeds? Juarez-Escario, A.
12.50-13.15	Poster presentation session 1
13.15-14.30	**Lunch**

Session 2	**Invasive plants in aquatic and riparian ecosystems** Chair: J. Haury & T. Le Bourgeois
14.30-15.10	**Invasive Plants in Irish Freshwaters – Impacts, Control and Management** **Keynote: Joe Caffrey**
15.10-15.30	Achene morphology affects water dispersal of the terrestrial invasive *Reynoutria* x *bohemica* Lamberti-Raverot, B.
15.30-15.50	Control of *Acer negundo* L.: insights from experimental and physiological studies Merceron, N.
15.50-16.10	Alien plant species along watercourses in the Natura 2000 network: a quantitative approach Monty, A.
16.10-16.30	Can plant soil feedback mechanisms result in complications for the management and habitat restoration of *Impatiens glandulifera*? Pattinson, Z.
16.30-17.00	**Coffee Break**
17.00-17.20	*Ludwigia grandiflora* subsp. *hexapetala* (Onagraceae) becomes invasive weed on flood-prone meadows in Brière marsh (Western France) Haury, J.
17.20-17.40	*Ludwigia* – a prime target for biocontrol in Europe Shaw, R.H.
17.40-18.00	Biochemical responses of invasive plants, *Ludwigia grandiflora* and *Ludwigia peploides* to water and salt stresses Barloy, D.
18.00-18.25	Poster presentation session 2

Tuesday, May 20th

Session 3	**Biology, Ecology, Evolution and Impacts of invasive plants** Chair: M.-C. Bon, P.-O. Cheptou, E. Kazakou & S. Novak
9.00-9.40	**Niche evolution and biological invasions** **Keynote: Sébastien Lavergne**
9.40-10.00	Contemporary evolution of *Senecio pterophorus* DC. in response to climate but not to herbivory. Castells, E.
10.00-10.20	Do soil microbes matter in plant invasions? A case study from Australia on five acacias and their associated soil microbial communities across non-native and native range populations Birnbaum, C.
10.20-10.40	Leaf traits associated with rapid resource acquisition and growth are greater in native than introduced genotypes of an invasive weed Alba, C.M.
10.40-11.00	Saprotrophic fungal diversity and abundance during litter decomposition of *Fallopia japonica* and native grassland species Mincheva, T.
11.00-11.30	**Coffee Break**
11.30-11.50	Mating system analysis of native and invasive populations of medusahead Novak, S.
11.50-12.10	Is the proportion of alien species in man made habitats influenced by city size? Čeplová, N.
12.10-12.30	Genetic diversity and hybridization in *Fallopia* Bzdęga, K.
12.30-12.50	Maternal environment affects plasticity to salinity of the exotic shrub *Baccharis halimifolia* L. invading estuarine communities Caño, L.
12.50-13.15	Poster presentation session 3
13.15-14.30	**Lunch**

Session 4	**Invasive plant management: biological and integrated control** Chair: P.E. Hatcher, M. Mekki & R. Sforza
14.30-15.10	**Integrated Weed Management: the use of biological control of weeds in agricultural and natural environment** **Keynote: Massimo Cristofaro**
15.10-15.30	LIFE+ Project Estuaries of the Basque Country: *Baccharis halimifolia* L. management and monitoring in the Atlantic coast Beteta, E.
15.30-15.50	The combined effects of defoliation by a biological control insect and a suppressive fodder plant upon the reproductive potential of invasive parthenium weed Shabbir, A.
15.50-16.10	Ecology and biological control of Blackberry: an unexpected result from south western Australia Scott, J.K.
16.10-16.30	Dispersal, impact and use of three fortuitously-arrived parasites in the control of invasive exotic plants in Valencia Deltoro, V.I.
16.30-17.00	**Coffee Break**
17.00-17.20	Status of biological control projects in California on terrestrial invasive alien weeds Smith, L.
17.20-17.40	Is biological control a solution to the international impacts of South African fireweeds: *Senecio madagascariensis* and *S. inaequidens*? Sheppard, A.
17.40-18.00	Biocontrol of South American aquatic weeds: international cooperation and *in situ* agent assessment in Argentina Cabrera Walsh, G.
18.00-18.20	Biological control of non-native invasive weeds in Europe: a piggy-back ride into the future Jones, K.
18.20-18.45	Poster presentation session 4

Thursday, May 22nd

Session 5	**Ragweed, joint session with COST Action SMARTER (Sustainable Management of *Ambrosia artemisiifolia* in Europe)** Chair: H. Müller-Schärer & B. Chauvel
9.00-9.40	**Accidental introductions of classical biological agents against invasive weeds in Europe - the ragweed leaf beetle as a case study** **Keynote: Urs Schaffner**
9.40-10.00	EU-COST Action on „Sustainable management of *Ambrosia artemisiifolia* in Europe (SMARTER)“: a template for future weed science initiatives Müller-Schärer, H.
10.00-10.20	Common ragweed national maps & public policies in France Mandon-Dalger, I.
10.20-10.40	No performance reduction at the present northern edge of *Ambrosia artemisiifolia* L. invasion range Ortmans, W.
10.40-11.00	Biology and Invasion Paths of *Ambrosia confertiflora* DC. nd *A. tenuifolia* Spreng. in Israel Yair, Y.
11.00-11.30	**Coffee Break**
11.30-11.50	Common ragweed: towards sustainable management solutions for Europe Thibaudon, M.
11.50-12.10	Common ragweed (*Ambrosia artemisiifolia* L.): Is the allergenicity of the pollen altered by climate change and air pollution? Frank, U.
12.10-12.30	The risk of exposure to airborne ambrosia pollen from local and distant sources – an example from Denmark Skjoth, C.A.
12.30-13.15	Poster presentation session 5
13.15-14.30	**Lunch**

Session 6	**Human perception of biological invasions** Chair: S. Brunel & H. Marchante
14.30-15.10	**Voluntary Codes of Conduct for botanic gardens and the horticultural trade to combat threats from invasive species** **Keynote: Vernon Heywood**
15.10-15.30	Prioritization in invasive alien plant management. How do you link the science to policy Sheppard, A.
15.30-15.50	How to communicate on pests and invasive alien plants? The experience from the European and Mediterranean Plant Protection Organization Brunel, S.
15.50-16.10	Japanese knotweed versus the general public: the battle royale Shaw, R.H.
16.10-16.30	How to define invasive plant for different sectors? : the way to a consensus Guérin, M.
16.30-17.00	**Coffee Break**
17.00-17.20	Reaching for allies: communicating on Invasive species in Portugal Gamela, A.
17.20-17.40	Human perception and institutional aspects of ragweed control Poortvliet, M.
17.40-18.00	In the shade of a Farnesian acacia: introduction and diffusion of a Mesoamerican species in Europe Fernandes, M.
18.00-18.20	Environmental risk assessment in support to plant health – the experience from EFSA (session 7) Tramontini, S.
18.20-18.45	Poster presentation session 6

Friday, May 23rd

Session 7	**New tools for Weed Risk Assessment (WRA) and for Early Detection and Rapid Responses (EDRR)** Chair: G. Brundu, I. Mandon-Dalger & A. Sheppard
9.00-9.40	**Weed eradication: feasibility and programme evaluation** **Keynote: Dane Panetta**
9.40-10.00	Harmonia+: a rapid risk-screening procedure for alien species D'hondt, B.
10.00-10.20	Predicting the invasion potential of alien plant species in Portugal using the Australian Weed Risk Assessment Morais, M.
10.20-10.40	The Implemetation of the Prioritization Process for Invasive Alien Plants in the Balkan Countries Marisavljevic, D.
10.40-11.00	Assessing the invasiveness of plant species from China Wang, H.
11.00-11.30	**Coffee Break**
11.30-11.50	Impact of alien plants in Europe on biodiversity and socio-economy: towards a unified system used for prioritization Markova, Z.
11.50-12.10	Early detection: from the regional to the national level Mandon-Dalger, I.
12.10-12.30	Warming network and tools for detection of new biological invasions in Reunion Island Triolo, J.
12.30-12.50	IT&C and citizen science for a better management of weeds in the Western Indian Ocean Region Le Bourgeois, T.
12.50-13.15	Poster presentation session 7
13.15-14.30	**Lunch**

SESSION 1

INVASIVE PLANTS IN MEDITERRANEAN REGIONS

Session Chair: Jordi Recasens, Abdelkader Taleb & Guillaume Fried

SESSION 1

INVASIVE PLANTS IN MEDITERRANEAN REGIONS

Oral presentations

KEYNOTE

Ecological impacts of alien plants

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Studies on the ecological impacts of non-native plants have increased exponentially in the last two decades. However, it is unclear whether there are strong patterns in terms of their major effects, how the vulnerability of different ecosystems varies, and which ecosystem services are at greatest risk.

A global meta-analysis of more than 1000 field studies has shown that non-native plants had a significant effect in 11 out of 24 different types of ecological impacts. However, these studies focus on a few plant species (i.e. 9 species account for 1/3 of studies). Moreover, the frequency for which an impact has been assessed is biased towards certain regions with Australasia as the most overrepresented. This presentation will identify the most studied species and the most studied impacts in Mediterranean regions, especially in Europe.

Cacti as alien species: a global review

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The cactus family (Cactaceae) comprises approximately 1850 species, distributed in the American continent throughout a large variety of habitats, including bare, hot deserts, sandy coastal stretches, scrublands, and even tropical rain forests. This wide variety of habitats has resulted in many cactus shapes and sizes. As a result of their diversity, beauty, and ease of cultivation, cacti species were introduced to Europe as early as the return trip from the first voyage to the New World in the 15th century. Several cactus species were soon found in the collections and gardens of Europe, and their interest to horticulturists as well as their trade throughout the world has continued since then. Currently, as a result of these human introductions, many cactus species have become serious invasive plants in Mediterranean regions, causing harm to livestock, crops and biodiversity.

Every year, new cactus species are exported outside their native range, and new species become invasive. One of the best predictors of invasiveness of introduced species is whether they have invaded in other parts of the world, Consequently, we compiled a global inventory of the status of cactus species as a tool for management. Broad-scale climatic matching is widely recognized as a fundamental requirement for the success of introduced plants. We identified areas of the world that are bioclimatically equivalent to the native area of the Cactaceae. Finally, we studied carefully some of their most distinguish morphological characteristics, uses and impacts and propose a list of potentially invasive cactus species.

Keywords: Cactaceae invasions; Reasons for introduction; Management

The reed cane *Arundo donax* L., an ancient Mediterranean invasive species originating from Middle East

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The hypothesis of an ancient introduction, *i.e.* of archaeophyte origin, is one of the most challenging questions in phylogeography. Today *Arundo donax* L. (Poaceae) is considered to be one of the worst invasive species around the globe, probably because it has been widely used by humans across Eurasia since the Neolithic. Despite a lack of phylogenetic data, the recent literature has often speculated on its introduction to the Mediterranean region. This study tests the hypothesis of its ancient introduction from Asia to the Mediterranean using chloroplast DNA sequencing and morphometric analysis on 127 herbarium specimens collected across subtropical Eurasia. In addition, we used a bioclimatic species distribution model calibrated on 1221 Mediterranean localities to identify similar bioclimatic conditions in Asia. Despite the analysis of several cpDNA hyper-variable sites and the identification of 13 haplotypes, *A. donax* was represented by only one haplotype from the Mediterranean to the Middle East. This haplotype is shared with invasive samples worldwide, and its nearest phylogenetic relatives are located along the Indus Valley (Middle East). Morphometric data characterized this invasive clone by a robust morphotype distinguishable from all other Asian samples. Our ecological niche modelling designated Southern Caspian Sea, Southern Iran and the Indus Valley as the most suitable region in Asia for the invasive clone of *A. donax*. Based on our integrative approach, we hypothesize an ancient dispersion of this robust, high polyploidy and non-fructiferous clone from the Middle East to the West, leading to its invasion throughout the Mediterranean Basin.

Keywords: *Arundo donax*; Invasive species; Archaeophyte; Clonal species

Drier climatic conditions may lead to increased herbivore pressure on a native tree, but not on an invasive competitor

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In the face of global climatic change, the interaction of pests and pathogens with their host plants becomes important. We investigated how an invasive plant (*Acacia mearnsii*) interacts with pests and pathogens in its invaded ranges and compare it to a related native species (*Virgilia divaricata*) in the Cape Floristic Region of South Africa. We determined how herbivore abundance and disease development differed between the two species across a moisture gradient and whether observed differences can be explained by moisture availability and/or foliar nutrient content. Both plants had similar foliar nutrient content, but measurements of δ13C isotope ratios in the foliage indicated that only the native plant experienced drought stress at the drier sites. The disease development was similar in both plants, but herbivore abundance was higher on the native plant. In contrast, herbivore numbers on *V. divaricata* increased at drier sites, indicating higher vulnerability to attack if climatic conditions become drier. *A. mearnsii* herbivore abundance were unaffected by moisture availability. Therefore, under conditions of increased drought, *V. divaricata* may experience higher levels of drought stress than the invasive *A. mearnsii* and may suffer from increased herbivory. Interestingly, herbivore abundance and disease development was significantly influenced by plant nutrient content for *A. mearnsii* and not for *V. divaricata*. Relatively nutrient poor *A. mearnsii* trees experienced higher herbivore loads and slower disease development than nutrient rich trees. Therefore, the susceptibility of *A. mearnsii* seems to be determined by plant nutrient levels, a factor that varies independently of moisture availability.

Keywords: *Acacia mearnsii*; Plant invasions; Ophiostomatoid fungi; Herbivory, Cape Floristic Region

A comparative study between the photoprotection strategies of an alien invasive species (*Cortaderia selloana*) with a native protected Mediterranean palm (*Chamaerops humilis*)

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Several studies have been performed regarding plant invasion success between alien invasive species and native protected plants from an ecological point of view. Additional approaches comparing physiological mechanisms underlying adaptation of native and invasive species are still needed to better understand the invasion potential of alien species. Here, we aimed at comparing photoprotection strategies between an alien invasive species (*Cortaderia selloana* (Schult. & Schult.f.) Asch. & Graebn) and a native protected Mediterranean palm (*Chamaerops humilis* L.). Furthermore, we evaluated to what extend the size of the native species can affect photoprotection and invasion success.

C. selloana showed higher photosynthetic performance (CO_2 assimilation and photosystem II efficiency) than *C. humilis*, thus reflecting an increased growth capacity in the former. However, *C. humilis* showed effective strategies to prevent photo-oxidative damage from the excess of light energy that was not processed on the electron transport chain, including (i) increased dissipation of excess excitation energy as heat through nonphotochemical quenching (NPQ) of chlorophyll fluorescence, and (ii) increased antioxidant levels.

The role of these photoprotection mechanisms and trade-offs between investments in growth and photoprotective defence responses will be discussed. It is shown here that photoprotection strategies should be considered among other ecophysiological traits to better understand the potential aggressiveness of new alien species.

Keywords: CO_2 assimilation; Photosystem II efficiency, Ecophysiological traits; Photoprotection mechanisms

Heads and tails in *Acacia dealbata* Link management: effectiveness of control and implications for native plants and soil microbial function

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Acacia dealbata Link is an aggressive invasive tree native from Australia and currently widely distributed in Mediterranean-type ecosystems. Despite the abundant literature concerning *A. dealbata* invasion processes, less attention has focused on managing its expansion. To our knowledge, this work represents the first approach to its control in Europe. Based on previous experiments, the present assay was carried out from April 2010 to June 2012 in an invaded area in the NW of Spain using direct herbicide (triclopyr) spraying and herbicide application after cutting of saplings and adult plants.

After herbicide application, biometrical measurements were periodically carried out and soil microbial community activity, plant diversity and plant species composition were monitored. *A. dealbata* individuals were severely affected by treatments, causing the dead of all treated individuals. Enzymatic activities and soil respiration were significantly enhanced when cutting and herbicide were applied in combination but not after herbicide application on its own. Species richness, diversity, evenness and cover were significantly reduced in the sprayed herbicide treatment one year after the last herbicide application, but the differences disappeared in the following spring. Plant species and functional group distribution were conditioned due to the treatment.

This study provides the first approach to *A. dealbata* management in Europe. The selected treatments produced promising results in terms of managing this invasive tree. Due to the effectiveness of treatments and the absence of long-term effects, further application of triclopyr would seem to be feasible to reduce *A. dealbata* spreading.

Keywords: Invasive plant control; Herbicide spraying; Soil enzymatic activity; Soil basal respiration; Species richness and plant diversity

A comparative study of life traits of alien versus native weeds of the crops of Oranie (North-West Algeria)

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The analysis of weed flora composition in the crops of Oranie (North-West Algeria) highlighted the presence of 30 alien species which are dominated by Asteraceae, Amaranthaceae and Solanaceae. Around 73% of these species were native to the American continent and 67% came from tropical regions. The most representative life traits in alien weed species compared to native ones were: spring to summer germination (73% vs 15%), non specialized dissemination strategies, but related with anthropic activities (70% vs 46%), strict to preferential self-pollination (73% vs 39%), and the high proportion of C4 species (23% vs 3%). The agricultural biotopes mainly affected were the irrigated summer crops with short rotation and important amount of nitrogen fertilization. The success of alien species seemed to result from suitability between environmental conditions of a newly created habitat (summer temperature, humidity, important nitrogen rate, frequent perturbations, short rotations, availability of ecological niches) and from species traits (annual type, summer germination, photosynthetic pathway in C4, speirochory).

Keywords: Agrosystems; Field surveys; Phylogeny; Biotypes; Speirochory

Solanum elaeagnifolium (Silverleaf Nightshade), a rising problem in the Mediterranean region

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Silverleaf nightshade (*Solanum elaeagnifolium*) is one of the most prominent invasive alien weeds in the Mediterranean Basin. It reproduces by sexual and vegetative means and occupies arable, pastoral, urban and sub-urban areas with a geographic range that is likely to accelerate under climate change. Furthermore, the species is toxic to some livestock. The extensive and deep perennial root system makes the weed extremely competitive for moisture and nutrients with many crops by resisting drought and tolerating saline conditions. Infestations are more significant in dry lands, although irrigated croplands are also prone to invasion. As a consequence, the specie is becoming a serious threat to agriculture in Mediterranean region. Limited control techniques currently available are uneconomical for the treatment of large, dense infestations. As a result, long-term and widely applicable options are required for a sustainable management, as well as the coordination of institutions involved in *S. elaeagnifolium* research and management throughout the Mediterranean Basin. In 2013, the 1st Mediterranean Workshop on SOEL attracted participants from 10 countries in the Balkans, Middle East and North Africa which are invaded by SOEL, as well as representatives of FAO and EPPO. After the meeting a taskforce formed to prepare a proposal for funding further study and control of the weed. We will present an update of the current situation of the SOEL invasion, its threats to agriculture, ecology and human welfares in these regions, and also identify the research needs including biological control, prevention and early detection, that were discussed during this workshop.

Keywords: *Solanum elaeagnifolium*; Alien weed; Control; Mediterranean region

Are irrigated crops and the surrounding riparian habitats linked by alien weeds?

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Many studies focus on alien plant diversity in natural habitats and, to a lesser extent, in agricultural habitats. However, few studies compare the alien plant species growing in crops with those established in the surrounding natural habitats. The aim of this work is to assess the level of similarity between the alien plant species in crops and the surrounding riparian habitats and to compare it with the level of similarity of the overall flora in these habitats.

For this purpose we surveyed weed communities in flood/drip irrigated orchards located at a distance of less than 50 to more than 250 m in a lateral gradient from the surrounding natural habitats (the floodplain) and in the habitats that compound this floodplain (frequently flooded bank, reed bed and riparian forest) along 22 kilometers of the Noguera-Ribagorzana river (Lleida, NE Iberian Peninsula). NMDS and dissimilarity index for overall and alien species were performed in order to find differences in the floristic composition between these habitats.

The results showed high differences between the overall composition of orchards plant communities compared to those of riparian habitats (Chao similarity index between orchards and riparian habitats ranges from 0,44 to 29,01). However, regarding alien plants composition, a higher similarity between alien plants present in orchards and those present in the frequently flooded banks was found (Chao similarity index from 29,23 to 67,06). These results indicated that alien weeds are shared by crops and frequently flooded banks and that fruit tree orchards may act as transitional habitats for the spread of alien weeds into other orchards and the surrounding riparian habitats.

Keywords: Alien plants; Irrigated orchards; Riparian habitats; Gradient; Chao index; Similarity

SESSION 1

INVASIVE PLANTS IN MEDITERRANEAN REGIONS

Posters

Distribution range of four dangerous non-native species in Italy

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Across the world, alien species have a negative impact on crops, biodiversity and ecosystems. Due to their toxicity or allergenic pollen, several alien species are also of great health concern. During the last two centuries in Italy, numerous non-native species have been listed in the Italian Flora; four species were considered particularly invasive and dangerous due to their high rate of occurrence in degraded habitats: *Ambrosia artemisiifolia* L., *Reynoutria japonica* Houtt., *Prunus serotina* Ehrh., *Senecio inaequidens* DC.

We present a contribution to the reconstruction of the distribution of these species across Italy by using herbarium specimens to outline their spatio-temporal invasion trends and habitat preferences. The preliminary distribution data collected during this work allowed producing distribution maps of such species.

Concerning habitat preference results showed that *A. artemisiifolia*, *R. japonica*, and *S. inaequidens* colonized road sides, rivers and abandoned fields. *P. serotina* preferred forest and wood areas. *A. artemisiifolia* was first reported in a botanic garden close to Turin in the 19th century, however it was only considered as a naturalized species in the first decade of 20th century in the area of Alba (TO). The other species seem to be of late spreading in Italy as most herbarium have been collected after 1950.

To understand and prevent invasion processes, contrasting measures are necessary both at local and international levels. The first stage is the assemblage of continental databases on the distribution and level of invasiveness of species, and then defining large scale action plans indicating the priorities of interventions.

Keywords: Herbarium record; Biological invasions; Adaptation; Disturbed habitat; Ecological and economic impacts

A catalogue of non-native weeds of irrigated crops in Sardinia (Italy)

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Arable land and agro-ecosystems are particularly affected by invasive alien plants which often produce economic damages due to crop yield losses, decrease in the quality of the product, in the palability of rangeland floras and promote a higher use of pesticides. Invaded agro-ecosystems could constitute foci for further invasion of surrounding natural habitats. Several studies were adrressed to the alien flora of Sardinia (Italy) and it islets but a specific study on presence and abundance on alien weed in irrigated crops was still lacking.

For this purpose, we screened all the available literature on alien plants to create an inventory dedicated to irrigated crops in Sardinia. The main sources were the national inventory made by Celesti-Grapow et al. in 2009 (Plant Biosystems 143) and other regional sources such as Moris (1827, 1837-1859), Chiappini (1985), Viegi (1993), Camarda (1982, 1983, 1998, 2001), Bacchetta et al. (2009), Podda et al. (2012), Arrigoni (Flora of the Island of Sardinia, 2006-2013). In addition, dedicated field surveys were done in areas devoted to different irrigated crops (e.g., corn, rice, vegetables, alfa-alfa) to verify and integrate the literature data.

The final inventory counts 159 alien plants in irrigated crops in Sardinia. The EPPO (European and Mediterranean Plant Protection Organisation) prioritization method was used to evaluate the risk posed by of each species, with the aim of establishing priority for actions and the most appropriate management procedures.

Keywords: Inventory; Neophytes; Agro-ecosystems; Prioritization

Evolution of the crop associated phytodiversity in Oranie (North-West Algeria) from Neolithic to nowadays

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This paper provides a checklist of the 92 archeophytes and 30 neophytes present in the crops of the oranian phytogeographical territory (North-West Algeria). Archeophytes were dominated by species from Poaceae, Brassicaceae, Asteraceae, Apiacaeae, and Fabaceae families. 52% of these archeophytes were of Irano-Turanian *sensu lato* origin. Among neophytes, Asteraceae, Amaranthacaeae, and Solanaceae dominate, 69% of which are of American origin. Speirochory (i.e. unintentional introduction) is the main pathway of introduction of those species. Neolithic and Antiquity are the most important period for species immigration while Middle Age period correspond to a sharp slowing down of new introductions. The colonial period, from 1850 to 1962, correspond to the period during which most neophytes were introduced, although the modern period, from 1990 up today, continues to see new introductions, including species among the most noxious weeds, yet with a lower rate.

Keywords: Archeophytes; Neophytes; Paleobotany; Life forms; Speirochory; Oranie (Algeria)

My name is Palmer Amaranth. I come from America

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Amaranthus palmeri S. Watson is a dioecious plant native of North America, where it causes significant yield losses in cotton, soya been and maize, and is developing different herbicide resistance mechanisms in Genetically Modified Crops. In the last years this species has been observed in several localities in NE Spain, where a road-side and maize field edge population was first recorded in Menàrguens in 2008. It was later observed in industrial areas of Lleida and road sides of Binéfar (Huesca). These three populations show clear naturalization through a great seedling emergence, development and successful fecundity. This species was also observed in two localities in the South of Spain, and in other places in central Europe, but its survival seemed not to be successful.

According to the habitat invaded, this case could be an interesting example to analyze and evaluate if threats of invasive weeds in agricultural systems are in the same consideration to those in environmental systems. Furthermore, different questions arise according to their recent introduction, behavior and invaded habitats in NE Spain: 1) Are these three populations originated from a unique initial spread point or did the colonization process take place separately? 2) Do these populations show phenotypic differences that provide them different availabilities to colonize one or more habitats? 3) Could these populations incorporate herbicide resistance genes? These and other questions define an interesting scenario for Palmer Amaranth to understand if an initial invasion process take place in NE Spain and if is necessary to develop a Pest Risk Analysis

Keywords: *Amaranthus palmeri*; Invader; Spain; Biological attributes

Parthenium hysterophorus L., a spreading invasive weed in Israel

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Parthenium hysterophorus (Asteraceae) is an annual plant (or short-lived perennial under certain growth conditions) native to the subtropics of North and South America. The plant has been introduced accidentally to Australia, India and many other countries in Africa, Asia and the Pacific where it is considered invasive weed. Within the EPPO region, its distribution is still limited, as occurrence has only officially been reported in Israel so far in the Bet She'an (Scyithopolis) Valley area (Dafni & Heller, 1982). In the last years the plant spread out of its initial establishment loci along roadsides. The entrance pathway is not known, but is probably via the import of grains from the USA, as was the case with other invasive species which entered Israel during the last 2 to 3 decades (Yaacoby 1998, Yaacoby et al 2001). *P. hysterophorus* is recorded in alfalfa, clover, tomatoes, cotton and forage fields (Joel & Liston, 1986, Rubin *et al*., 2010), and dates in Israel (T. Yaacoby, pers. Obs, 2013). Survey took place during summer 2013 showed that *P. hysterophorus* continue to spread and its infesting almost every space of the Jordan Valley; avocado, dates and banana orchards, in villages (kibbutz) gardens and along field and driving roads.

Keywords: *Parthenium hysterophorus*; Import of grains; Forage fields

Looking for a threshold impact of groundsel tree (*Baccharis halimifolia* L.) on Mediterranean saltmarsh communities: comparison with a native shrub

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Baccharis halimifolia (Asteraceae) is a North American shrub introduced for ornamental purposes and considered as invasive in France. That invasive species forming dense thickets can have an impact on resident communities seems obvious. However, three issues that remain poorly understood are addressed here: i) to what extent may impact vary from site to site? ii) does the impact following establishment of *B. halimifolia* differ from that of a native shrub (*Tamarix gallica* L.) during natural successions? iii) are there impact thresholds above which native species richness and/or cover declines rapidly?

Vegetation has been sampled in two regions in the South of France (Camargue, Roussillon), each including three different sites with plots variously invaded by *B. halimifolia*, plots dominated by *T. gallica* (native shrub) or plots without a shrub layer (control). Different models (GLMM) were built to explain variations in native species richness and/or cover. To assess the nature of the relationships between invasive species cover and impact (linear or sigmoid), linear regressions were compared to cubic regressions.

B. halimifolia significantly reduced native species richness, with no significant differences between regions and sites. Impacts of *B. halimifolia* were stronger than those observed for the native shrub *T. gallica*. Species richness declined linearly with increasing cover of *B. halimifolia*, while changes in native species cover were better described by a cubic regression with a threshold cover of *B. halimifolia* of around 90%. Future research will be needed to validate the use of impact thresholds as an efficient conservation strategy for invaded landscapes.

Keywords: Species richness; Impact threshold; Community structure; Natural succession

A new weed in fruit orchards: tree of heaven (*Ailanthus altissima* (Mill.) Swingle)

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Fruit production is an important economic sector in the Iğdır Province of Turkey. Tree of heaven (*Ailanthus altissima* (Mill.) Swingle), which is a native of China, was recorded in two apple orchards which are next to each other. It has been planted in Iğdır like the other parts of Turkey as ornamental and forestation tree to prevent erosion by authorities and then spread through in and around city. In addition, people plant it their home gardens and around fields for shading in Iğdır. It is supposed that these all are the reason for infestations. Tree of heaven mainly grown next to apple trees in the orchards because tillage had been a common practice between rows, which does not allow tree of heaven grow. Despite saplings/trees of tree of heaven near apple trees cut by saw in spring, new offsprings were determined in early summer and became a tree during summer. The diameter of apple trees that were next to tree of heaven compared with the diameter of surrounding four apple trees. There was no significant difference. However, it could not be interpreted that tree of heaven does not have impact on apple tree because roots of the tree of heaven spreads through orchard. Economic impact of tree of heaven on apple tree needs to be further studied.

Keywords: Tree of heaven; *Ailanthus altissima*; Apple orchard; IAP; Weed

Presence of weeds and invasive plants in agricultural seeds

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Agricultural crops can be vulnerable to the presence of unwanted, even invasive weeds. The species, which contaminate crop seeds, are not only an environmental problem; they are also an economic problem. These plants can affect the performance of farmland, forcing a consumption of resources to control their presence.

A measure to prevent the presence of invasive plants is integrated weed management, including the use of certified seed in agricultural crops. The seed standards, from EU directives, establish limits for the presence of weed seeds for certified seed lots, with specific restrictions per weed species.

However, certification does not offer a complete guarantee that unwanted species will not be introduced into the agro-system. The presence of seed contaminants, although at minimum percentages, may actually represent the introduction of a large number of seeds in the field due to the high densities used for sowing. The introduced species during sowing could potentially become invasive weeds if they are not removed from the soil the following seasons. We intend to study the issues related to the presence of weeds and/or invasive species in agricultural crops caused by residual contamination of certified seed lots.

In this study, we assess the presence of seeds (of weeds and/or invasive species) and we identify the dominant unwanted species (Emergency Test) in seed lots provided for certification to the Seed Testing Laboratory (INIA).

Keywords: Agro-systems; Certified seeds; Contamination; Directive; Sowing

Two invasive parasitic plants: *Cuscuta campestris* Yunch. and *C. approximata* Bab. their distributions, hosts and germination biology

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Dodders (*Cuscuta* spp.) are stems and branches holoparasites of many crop plants. Approximately 120 dodder species have been recorded all over the World. Among which sixteen species exist in the flora of Turkey. Three dodder species are economically important in agriculture area in Turkey as well as in many countries. Which are *C. campestris* Yunck., *C. approximata* Bab. and *C. monogyna* Vahl. *C. campestris* is native in North America and is distributed all over the World. *C. approximata* is native to the old World and had been introduced into North America while *C. monogyna* is native to the old World and spread around its native area. In this study germination biology of *C. campestris* and *C. approximata* were investigated under different temperature (5, 10, 15, 20, 25, 30, 35°C). According to the results of this study, optimal germination temperatures ranged between 20 and 35°C for *C. campestris* and between 15-25°C for *C. approximata*. At the other hand, distribution and hosts of those two parasitic species were observed in Turkey. *C. campestris* is distributed all over the Turkey although less frequent in the Black Sea Region. This species prefers sunlight. It is assumed that *C. campestris* was introduced in Turkey in 1925 via imported seeds and then distributed all over the countries. It has more than 40 host species includingboth weeds and crop plants in Turkey. *C. approximate* mainly attacks lucerne (*Medicago sativa* L.) and is called alfalfa dodder. It seems to be specific to lucerne and it has not been yet recorded in other crop plants in Turkey.

Keywords: Invasive parasitic plants; Seed germination; *Cuscuta campestris*; *Cuscuta approximata*

Eradication program against *Opuntia rosea* DC. in the municipality of Celles, Hérault (France)

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The Salagou area is characterized by the presence of fine-grained sandstone, constantly revived by active erosion. It currently forms a landscape alternating areas of low scrubland and bare eroded soil, strongly marked by aridity. It is within this landscape that the presence of a cactus unknown in the wild was first observed in 2005 by an agent of the National Hunting and Wildlife Agency. This information was forwarded to the Mediterranean National Botanical Conservatory and the development of *Opuntia rosea* DC. has been monitored during several years.

The biggest individuals reached 1.50m high and 3m wide, forming a "kind of shrub composed of cucumbers and bristling with long sharp spines" as described by a resident. The spines easily penetrate the skin and are difficult to extract (and also pass through shoe soles, tires,...). The number, size and shape of the spine as well as a high vegetative reproduction through cladodes led botanists to propose eradication. The harmful effects of this cactus, mainly on the recreational usage value of natural areas have encouraged local actors to support the eradication effort.

The eradication program began in 2009. It involved the General Council of Hérault (which provided significant logistical requirements for grubbing, transport and burial of the large plants uprooted) and professionals of the environmental sector and local elected officials. It proves necessary to carry on for several years, as the regeneration capacity of the plant is important. After four years of regular surveys and uprooting, many juvenile plants are still collected steadily. To better understand the phenomena of dissemination and to ensure the success of the eradication effort, three monitoring plots have been established and will be followed starting in the spring 2014.

This experience illustrates the possibilities of a successful eradication campaign involving local stakeholders, although post-eradication monitoring will still be necessary for several years.

Keywords: *Opuntia rosea* DC.; Eradication; Monitoring; Local actors; Usage value

Studies on *Oxalis pes-caprae* L.: an invasive alien plant in Turkish Republic of Northern Cyprus

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In recent years 85 alien plant taxa have introduced to the Cyprus Island and established in cultivated areas. Within these species, is remarkable the presence of *Oxalis pes-caprae*, a native plant from Cape Region (South Africa). The species was introduced to Crete and Cyprus in 1880 and nowadays is well established in all over Cyprus Island. The geographic distribution of the species is related to agriculture activities and it is well known as a troublesome weed as well as an environmental invasive plant. The aim of this study is to determine the frequency, coverage and density of *O. pes-caprae* in barley fields in Turkish Republic of Northern Cyprus. For two years 28 barley fields were surveyed, and the frequency of the species was 100% in 2013 and 86% in 2014. The mean values of coverage were 85% in 2013 and 30% in 2014. These values seem to be in correspondence with the higher rainfall recorded in 2013. A negative correlation between coverage percentage of *O. pes-caprae* and density of other weeds was also found. *O. pes-caprae* shows a polymorphism in their flowers. There are four type floral morphs (short-styled, mid-styled, long-styled and sterile form) on their flower. In the area surveyed only short style type of flowers was observed; that means no sexual reproduction occurs. But, it does not prevent spread of plant.

Keywords: Agro-ecosystems; Troublesome weed; Barley fields; Vegetative reproduction

Drivers of invasion of *Ailanthus altissima* (Miller) Swingle and *Robinia pseudoacia* L.: a multi-scale approach

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The influence of climate, land use and human-mediated disturbances on the present distribution of the invaders *Ailanthus altissima* (Miller) Swingle and *Robinia pseudoacacia* L. was investigated at three spatial scales: at global scale (10 arc minutes grid cell), at regional scale –Spain- (5 arc minutes grid cell) and at local scale –three riparian floodplains within Spain- (100 m grid cell). For each species and scale we built a set of species distribution models (SDMs)–using presence records and background samples as pseudo-absences- and applied a committee averaging method to extract a single output. We generated maps of their potential distribution in Spain. At the global scale, distribution of both invaders was mainly driven by climatic factors, whereas land use and human-mediated disturbances were less important for their occurrence. At the regional scale, land use gained relative importance as a predictor, even though the major effect of climate still persisted. The effect of human-mediated disturbances, although positive, largely differed between species. At the local scale, the presence of both species was primarily associated to the proximity to the river and human-mediated disturbances gained explicatory power to the detriment of climate. Within Spain, the most suitable areas for *A. altissima* are the Mediterranean coast, the Ebro valley and the centre of the country, whereas the most suitable areas for the occurrence of *R. pseudoacacia* are the northern coast and the northeastern corner of Spain.

Keywords: Invasive alien plants; Distribution; Risk maps; Scale; SDMs

SESSION 2

INVASIVE PLANTS IN AQUATIC AND RIPARIAN ECOSYSTEMS

Session Chair: Jacques Haury & Thomas Le Bourgeois

This session is sponsorised by ONEMA through the GT IBMA (French working group on Biological invasions in Aquatic Environments)

SESSION 2

INVASIVE PLANTS IN AQUATIC AND RIPARIAN ECOSYSTEMS

Oral presentations

KEYNOTE

Invasive Plants in Irish Freshwaters: Impacts, Control and Management

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As an island on the western edge of Europe, Ireland is fortunate to possess a relative paucity of non-native species that can be deemed to be truly invasive. However, those that have been introduced and have become established do pose considerable problems for our unique aquatic ecosystems, for amenity exploitation in our waterways and for the Irish economy. Foremost among these species are: *Lagarosiphon major*, *Elodea nuttallii*, *Crassula helmsii* and the riparian species: *Reynoutria japonica*, *R.* x *bohemica*, *Persicaria wallichii*, *Impatiens glandulifera* and *Heracleum mantegazzianum*. A number of other non-native aquatic plant species that are proving to be highly invasive in other countries, even our nearest neighbours in the UK, are present in Ireland but are not yet exhibiting invasive tendencies or traits here. These include *Myriophyllum aquaticum* and *Lemna minuta*. Still others have successfully established in Ireland but have either been successfully eradicated via rapid management reaction (e.g. *Ludwigia grandiflora*) or have been controlled by the inadvertent introduction of a specific biological control agent (e.g. *Azolla filiculoides*).

The paper will describe the impacts that selected invasive aquatic and riparian plants have had on Irish freshwater ecosystems and the management measures that have been implemented to control the plants and mitigate their impacts. Particular focus will be paid to two species where significant financial and logistical resources were expended in an effort to achieve control. In one instance, with *Lagarosiphon major*, a high level of control was achieved through the development of practical, novel and highly targeted control measures. With another species, *Crassula helmsii*, wide ranging and extensive management activities failed to control the expansion of the invasive plant in the targeted watercourse. The reasons for the success and failure with these and other plant species, and the implications for future management, will be discussed.

Keywords: Biodiversity; Biosecurity; Long-term control; Restoration; Containment

Achene morphology affects water dispersal of the terrestrial invasive *Reynoutria* x *bohemica*

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Watercourses are important vectors for plant dispersal and even more for invasive species. Propagule dispersal along watercourses can highly enhance migration distances of invasive riparian plant species, even for species not primary adapted to this dispersal mode. The invasive complex of hybrids *Reynoutria* x *bohemica* Chrtek & Chrtkova highly colonises riverbanks and produces large amounts of fertile achenes. The aim of this study was to analyse water dispersal capacities of these achenes and the relationship between their morphology and ability to float.

Achenes of *R*. x *bohemica* were collected from 60 stands growing along watercourses and their floating force was measured experimentally using a load cell ballasted in an aquarium. Morphology of 100 achenes per site was measured by principal components scores based on elliptic Fourier descriptors.

Flotation was positively correlated to achene size (mass and surface). Floating force corrected for achene size differed between *R*. x *bohemica* stands sampled and was correlated to achene shape: particularly, rounded fruits had a better flotation than elongated ones. Furthermore, achene morphologies varied significantly between rivers, suggesting that rivers are colonized by different populations of *R*. x *bohemica*.

These results demonstrate that some morphological traits can enhance buoyancy of fruits for *R*. x *bohemica* complex. This may constitute an adaptive advantage for water dispersal contributing to the invasiveness of the species.

Keywords: Water dispersal; *Reynoutria* x *bohemica*; Buoyancy; Morphology; Plant invasion

Control of *Acer negundo* L.: insights from experimental and physiological studies

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Native to North America, *Acer negundo* was introduced in Europe during the seventeenth century (in France around 1749, Lair 1827, Williams 2008). Largely used as an urban tree, its ongoing invasion mainly takes place in riparian habitats; its current distribution now extends all through Europe (Medrzycki 2007). It forms mono-specific stands outcompeting riparian native trees (Lamarque et al. 2012), and leading to deterioration of river banks. By ratifying the Rio Convention, France has engaged in controlling such invasive species.

Although the most efficient control methods would consist in the use of chemicals, we decided against these techniques as most chemical are not allowed in wetland areas. An experimental design was settled to test ecological-friendly methods to control boxelder in South-West France: stem-base cut, 1 m height cut, girdling and stem cut with juglone insertion. During two years, tree mortality was assessed. Girdling resulted in the highest mortality rates, varying from 32% to 100% according to the site, suggesting that this method could require a longer application to reach full success in the field.

Boxelder is capable of a high plasticity in response to increased light or nitrogen availability that promotes its growth compared to native species (Porté et al. 2011); thus it is desirable to implement this treatment a few years before any cutting (ex. wood harvesting) or after a natural disturbance (ex. opening due to wind storm or flooding). This could help controlling Boxelder and preventing the development of mono-specific maple riparian forests.

Keywords: Integrated control; Riparian habitats; Plasticity; Boxelder

Alien plant species along watercourses in the Natura 2000 network: a quantitative approach

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Natura 2000 is the centerpiece of EU nature and biodiversity policy. It is a European wide network of nature protection areas aiming at assuring the long-term survival of Europe's most valuable and threatened species and habitats. However, alien plants do not stop their spread at the border of protection areas and invasive plants are reported to threaten aquatic and riparian ecosystems.

Our study aimed at assessing the plant invasion threat along watercourses within the Natura 2000 in Southern Belgium. A stratified random sampling, based on the natural region and the size of the watershed, was conducted. 187 sections of watercourses bank were visited between May and September 2013. For all recorded alien species, data were collected about local abundance, competitive impacts, regeneration potential and ecological conditions. 51 alien species were observed. Some were widespread (e.g. *Impatiens glandulifera*, with 17 % of linear banks invaded) whereas others were either rare or considered emergent alien species. Emergent species, showing low occurrence but high impact index, are appropriate target species for early detection programs and preventive management actions. Analyses showed that typical riparian species' occurrence increased with the size of the watershed, indicating propagule pressure within protected areas through hydrochory. No link could be established between the presence of disturbance(s) and alien species in the considered N2000 sites.

Keywords: Natura 2000; Alien flora; Neophytes; Early detection; River bank

Can plant soil feedback mechanisms result in complications for the management and habitat restoration of *Impatiens glandulifera*?

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Impatiens glandulifera Royle is one of the most widely occurring non-native invasive species in the UK. Here we present the results of two studies that (1) evaluate plant soil feedback (PSF) mechanisms of *I. glandulifera* and (2) assess the impact on native species following a reduction in arbuscular mycorrhizal fungi (AMF) from beneath stands of *I. glandulifera*. For the first study, *I. glandulifera* plants were grown in preconditioned (previously invaded) and control (uninvaded) soils. The soil and foliar microbial communities were assessed. The results show for the first time that *I. glandulifera* displays a positive PSF which alters the soil microbial community in favour of bacteria, as well as the above-ground foliar endophyte community. In the second experiment, native plant species (*Plantago lanceolata*, *Lotus corniculatus* and *Trifolium pratense*) were grown in invaded and uninvaded soils. All native species had a higher percentage colonisation of AMF when grown in uninvaded soil compared to the corresponding invaded soil. *P. lanceolata* and *L. corniculatus* had a higher biomass when grown in uninvaded soil compared to corresponding invaded soil indicating an indirect impact from the non-native species. We suggest that simply managing invasive populations of non-native species that are weakly dependent on AMF is inadequate for habitat restoration, as native plant colonisation and establishment may be hindered by the depleted levels of AMF. Furthermore, increases in foliar endophytes may enhance resistance to natural enemies, thus further accentuating the invasive properties of this species. These changes in microbial communities could have implications for restoration and biocontrol practices.

Keywords: Ecological impacts; Microbial community; Arbuscular mycorrhizal fungi; Habitat restoration

Ludwigia grandiflora subsp. *hexapetala* (Onagraceae) becomes an invasive weed on flood-prone meadows in Brière marsh (Western France)

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Large Waterprimrose, *Ludwigia grandiflora* subsp. *hexapetala* (Hook. & Arn.) G.L.Nesom & Kartesz (Onagraceae), is expanding on flood-prone meadows in many places, especially in Brière marsh. Thus can we explain such expansion and what are its effects on the biodiversity and the cattle breeding?

Our hypotheses are:
(i) that tropical plant becomes invasive due to its large ecological range, but some patterns of distribution can appear, leading both to local risk analysis and areas to survey;
(ii) adaptations to terrestrial conditions lead to changes in biomass and plant morphology,
(iii) it has an effect on the meadow biodiversity.

Considering field research since 1998 on its distribution and local plant diversity, phenology, biomass and distribution mapping, adaptations are summarized and consequences for managers are underlined.

Keywords: Wetlands; Biological invasion; *Ludwigia*; biomass; Phenoplasticity

Ludwigia – a prime target for biocontrol in Europe

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Ludwigia peploides (Kunth) P.H.Raven and *Ludwigia grandiflora* (Michx.) Greuter & Burdet are highly invasive aquatic weeds native to North, Central and South America, but which are now well established in parts of Europe. Able to double in biomass in 2-3 weeks these plants can quickly clog water bodies, release allelopathic chemicals, outcompete native species, reduce water quality and damage fragile aquatic environments. Vast amounts of money have been spent trying to control *Ludwigia* species in Europe, but with little success in preventing the impact and spread of these weeds.

In the UK where few, small populations of *L. peploides* have been identified, the weed is subject to an eradication programme in an attempt to prevent the invasion becoming as problematic as it is in France, where chemical control measures are not permitted and mechanical removal results in fragmentation of the plant which can exacerbate infestations. It is clear that large scale control using traditional methods is expensive and ineffective and that a more sustainable solution is needed.

Classical biological control is a safe and effective alternative method of control with an excellent track record against invasive aquatic weeds. This presentation will consider the remarkable successes of aquatic weed biocontrol and highlight the potential for biocontrol of *Ludwigia* species with reference to promising natural enemies already identified in the native range. Host range studies tailored to Europe are now required to determine the safety and potential of these agents amongst others from the plant's area of origin. The stage is set for biological control to finally bring *Ludwigia* under control.

Keywords: *Ludwigia*; Biological control; Natural enemies

Biochemical responses of invasive plants, *Ludwigia grandiflora* and *Ludwigia peploides*, to water and salt stresses

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Biological invasions are the third cause of biodiversity decline. The Water Primroses *Ludwigia grandiflora* (Michx.) Greuter & Burdet and *Ludwigia peploides* (Kunth) P.H.Raven are two invasive aquatic species in France. They have important impacts, both economical and ecological. The strategies currently used to fight their invasion revealed serious difficulties to have an effective management.

In order to determine if these species have a better plasticity than the native species *Mentha aquatica* L., water stress and salt stress were applied to the three species for five days. Biochemical analyses have been realized to evaluate global strategies of response to stresses and the mobilization of antioxidant pathways.

Results showed differences in the responses depending on stress and species. Salt and water stresses impacted photosynthetic activity and proteins concentration, suggesting that an oxidative stress occurred. To deal with salt stress, guaiacol peroxidase was mobilized by *L. grandiflora* and *L. peploides*, while *M. aquatica* used glutathione reductase to scavenge reactive oxygen species. According to the biological variables studied, the two invasive species seem more plastic than the native one. Differential responses in favour of *L. grandiflora* were noted compared to *L. peploides*. Their different ploidy level, higher for *L. grandiflora*, can explain difference.

Other antioxidant enzymes or some reactive oxygen species could be dosed to bring complementary results.

Keywords: Invasive water primrose; Plasticity; Abiotic stress; ROS; Antioxidant enzyme

SESSION 2

INVASIVE PLANTS IN AQUATIC AND RIPARIAN ECOSYSTEMS

Posters

Interactive image-driven identification of non-native aquatic plants

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Information on non-native plants has been compiled at species level including advise on their management. However, first you need to know what species you are dealing with. Therefore tools to facilitate their identification are a prerequisite. Focus was on species that pose a (potential) threat to the biodiversity of the ecozone comprising northern Germany, The Netherlands, Belgium and northwest France. Some species that might be found as contaminant in commercial exports originating from the Netherlands are also included. This information is now available at http://www.q-bank.eu/plants/.

Image driven, interactive identification keys are added to the information system. The keys allow you to choose the drawing matching the character state that best represents the plant you are trying to identify. By choosing several characters that are visible in your plant you narrow down the number of species that match you plant. All species in the keys are illustrated by numerous photographs and a full description of the character states for each species is given. The keys can be used for various growth stages in a range of 'habitats': seed identification of contaminants in birdfeed, weeds in bonsai plants, seedling identification, invasive terrestrial plants and invasive aquatic plants. Image driven identification helps to avoid misunderstandings in terminology. The interactive, multiple entry system serves identification in the absence of certain characters, which is often the cause of failure in dichotomous keys. The keys are linked to the species information in the database, including datasheets, distribution maps, specimen information etc.

Keywords: Invasive species; Identification tools; Aquatic plants; Non-native plants

Biology, ecology and fertility of Water Primroses (*Ludwigia grandiflora* subsp. *hexapetala* and *Ludwigia peploides* subsp. *montevidensis*): variability and consequences for management in Western France

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Waterprimroses (*Ludwigia grandiflora* subsp. *hexapetala* (Hook. & Arn.) G.L.Nesom & Kartesz and *Ludwigia peploides* subsp. *Montevidensis* (Spreng.) P.H.Raven) are expanding in Western France and become fertile, depending on species, populations and sites. A review on existing data in literature on biology and ecology of both species in Western France is presented in a first part.

Results on fertility obtained on more than twenty populations/years are presented. Differences between species exist: in many cases, *L. peploides* has higher germination rates than *L. grandiflora.* Vernalisation increases much germination rates in any case, up to more than 80%. Aquatic and terrestrial populations present small differences in the same site, but autumn collection followed by laboratory cold exposure are less efficient than spring collection after winter cold. Field seed production is important with more than 40,000 seeds produced per m².

The possibility of seed dispersal when flooding exists, and we observed *in situ* seedlings on some meadows. Thus fertility modifies cattle-breeder practices and all wetland management in heavily colonised sites, with special attention paid to early stages of establishment.

Keywords: *Ludwigia*; Population; Fertility; Adaptative strategy

Biological response of dominant aquatic weed species on the presence of herbicides and their metabolites in canal water

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The vegetation of canal Vrbas-Bezdan builds floating stands of ass. *Nymphaeetum albo-luteae* Nowinski 1928, *Hydrocharidetum morsus-ranae* Van Langendonck 1935, *Lemno-Spirodeletum* W. Koch 1954 and *Salvinio-Spirodeletum polyrrhizae* Slavnić 1956 and the submerged stands of ass. *Ceratophylletum demersi* (Soó 27) Hild. 1956. The presence of herbicides and their metabolites in water can contribute to biological spectar (impact on hydrophytes) and affect their biological properties, due to the adoption of their residues. The samples for water analyses were taken from canal from the locality of Vrbas (45°34′10″N/ 19°38′16″E) away from the zone of direct influences of waste waters and tributaries influx. LC-MS/MS multi-residue method was used for the determination of 21 herbicides and the products of their transformation with atrazine-d5 and isoproturon-d6 as an internal standard in surface water. The detected residues of terbutilazine-desethyl and prometryn were above the MACs while all the other herbicides detections were under MACs. The influence of their presence in canal water was studied in aquatic species *Lemna minor* L., edificator of very widespread ass. *Lemno-Spirodeletum* and *Ceratophyllum demersum* L., edificator of ass. *Ceratophylletum demersi*, in the semi-controlled conditions. The quantities of photosynthetic pigments (chlorophylls a, b and carotenoids) were higher in the measured values of the sampled water in comparison with the control. The fresh weight of a plant, was greater in the plants grown in the control (30.24 to 42.20%) in comparison with the sample (11.35 to 15.95%). The quantities of soluble protein had higher values of the control (grown in water without herbicide residues) in comparison with the sample (4.0-7.74%).

Keywords: Canal water; Herbicides; *Lemna minor* L.; *Ceratophyllum demersum* L.

Preliminary study on the ecological requirements and establishment success of the Japanese hop (*Humulus japonicus* Siebold & Zucc.) in France

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Humulus japonicus is an annual vine from Eastern Asia introduced to Europe and to the USA for ornamental purposes at the end of the 19th century. Its invasiveness is considered high in some countries, including Hungary and the USA. In France, it is considered as an emergent invasive species with recently naturalized populations on the banks of the Gardon River (SE of France).

Determining the ecological requirements of *H. japonicus* is expected to allow identification of the habitats most vulnerable to its invasion. This preliminary study aims to explore the influence of dispersal and abiotic and biotic filters on the success of *H. japonicus*. The cover of *H. japonicus* was measured in 30 2x2m quadrats arranged along the river banks in May 2013. Propagule pressure (dispersal filter) was estimated as the number of seedlings in early spring. Soil moisture, light availability and nutrient level (abiotic filters) were estimated through the mean Ellenberg scores based on the vegetation composition of each quadrat. Finally, the cover of established plants was calculated as a measure of biotic filtering. A Detrended Correspondence Analysis (DCA) based on species presence-absence in the 30 quadrats was carried out, in which *H. japonicus* cover was added as a supplementary variable. A permutation test was then performed to explain the DCA axes based on the three kinds of filters.

High densities of *H. japonicus* were mainly correlated with high soil moisture and low cover of other plants. Number of seedlings was also key parameter. A more comprehensive sampling, associated with a statistical model, will allow estimation of the relative importance of each of these variables in the establishment success of *H. japonicus*.

Keywords: Invasive vine; Ecological filters; riparian habitats

A French working group on Biological invasions in Aquatic Environments

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The spread of invasive alien species in freshwater may cause negative impacts on the native biodiversity, human activities and health, also resulting in significant economic consequences. Local stakeholders face common limits, such as low public awareness or limited access to information. In order to respond to these critical issues, a French working group on « Biological Invasions in Aquatic Environments » was created in 2009 with the objectives to increase management capacities by developing guidelines and operational tools intended for managers and decision-makers. Coordinated by the French National Agency for Water and Aquatic Environments (ONEMA) and the IUCN French Committee, this working group brings together more than 40 experts and stakeholders involved in the different aspects of IAS management including researchers, natural area managers, NGOs, local authorities, etc. The working group's activities are determined by the shared needs of the formed network. Examples of projects include: 1) the development of a dedicated website (http://www.gt-ibma.eu/) to provide access to information such as protocols for control, strategies and regulations in force and others useful websites; 2) the publication of a best practices management guide with fully detailed management experiments on aquatic invasions; 3) the setting up of a database on introduced aquatic species in France.

The working group is an interface between different stakeholders. It improves communication, ensures the integration and accessibility of the available information and helps the coordination of management actions. It provides useful information for the French national strategy in progress, by targeting the priority needs of managers in order to tackle biological invasions.

Keywords: IAS management; Best practices; Operational tools; Guidelines; Working group; Aquatic environments

Invasive plant management coordination in France: role of territorial working groups

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Invasive plant management difficulties emerged in France in the 70s, mainly in the South-West, and gradually spread from the Atlantic seafront to Brittany. Limited interventions on a few highly colonized sites were undertaken at the end of this same period. Several assessments from the 80s demonstrated the breadth of the difficulties that remained unsolved, like the necessity to coordinate efforts and stakeholders in order to maximize actions and expenses.

For this reason, working groups allowing this coordination emerged in the early 2000s. They cover various administrative territories, from a whole river catchment like the area of the Loire-Bretagne Water Agency, to a county in the case of the Charente, or a region like the Pays de la Loire Committee for the management of invasive plants. Some of these groups have been existing for more than a decade and have made possible, on their territory scale, the collection of information and the distribution maps of invasive plant as well as the standardization of management interventions. They have also highly contributed at a national scale to the diffusion of information on the ecology of these species and on the technical and organizational aspects of their management. Armed with this experience, these working groups are now broadening their actions on invasive fauna, making use of the existing network and underlying skills.

Keywords: Invasive plant management; Coordination; Working groups

Associated insect guilds with the invasive *Ludwigia peploides* and *L. grandiflora* (Oligospermum section) in their native range

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The South American water primroses *Ludwigia grandiflora* (Michx.) Greuter & Burdet*, Ludwigia grandiflora* subsp. *hexapetala* (Hook. & Arn.) G.L. Nesom & Kartesz*, Ludwigia peploides* (Kunth) P.H. Raven, and *Ludwigia peploides* subsp. *montevidensis* (Spreng.) P.H. Raven (Onagraceae, Section Oligospermum), have become invasive in several watersheds of Europe, Asia and the U.S.A.

Surveys were carried out in central and northern Argentina to find organisms that might serve as biological control agents. More than 20 insect species were found to feed on *L. g.* subsp. *hexapetala*, distributed in a variety of guilds, including 6 species with stem-borer larvae, 1 species with fruit-feeding larvae, 4 species with defoliating larvae, 2 species with defoliating larvae on young leaves and axil meristems, 1 species of cell content-feeder, and 3 species of sap-feeders. Nine of these species also have defoliating adults.

The cell-content feeder *Liothrips ludwigi* (Thysanoptera), and a number of stem-boring weevils are promising candidates as biocontrol agents for the countries where this plant is an aggressive invader.

Keywords: Biological control; Aquatic weed; Natural enemies

Water hyacinth and its bio-controls: South America produced the problem and the solution

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Water hyacinth, *Eichhornia crassipes* (Mart.) Solms, is one of the world's worst weeds because it has characteristics that gives it rapid vegetative growing, competing successfully for light, rapid leaf changes mediated by environmental conditions, resprout from the rhizome after winter frosts, and a high seed production with a long viability.

Water hyacinth is a South American species, so this is where the highest diversity of natural enemies is found. The Foundation for the studies of invasive species (FuEDEI, formerly USDA-ARS-SABCL) studies biocontrol agents and exports them from Argentina. The most effective are: *Neochetina eichhorniae* and *Neochetina bruchi* (Col., Curculionidae); *Orthogalumna terebrantis* (Acari: Galumnidae); *Niphograpta albiguttalis* and *Xubida infusella* (Lep., Crambidae); *Megamelus scutellaris* (Hemip., Delphacidae).

Two additional specific candidates are still available: a mining fly, *Thrypticus truncatus* (Diptera, Dolichopodidae), which facilitates the entrance of pathogens in the leaf petioles; and a planthopper, *Taosa longula* (Hemiptera, Dictyopharidae) which produces yellowing and decay of plants.

These natural enemies in combination attack the rhyzomes, the petioles and laminae, affecting the energy budget and health of the plants.

Keywords: Biological control; *Eichhornia crassipes*; Natural enemies; Aquatic weed

SESSION 3

BIOLOGY, ECOLOGY, EVOLUTION & IMPACTS OF INVASIVE PLANTS

Session Chair: Marie-Claude Bon, Pierre-Olivier Cheptou, Elena Kazakou & Steve Novak

SESSION 3

BIOLOGY, ECOLOGY, EVOLUTION & IMPACTS OF INVASIVE PLANTS

Oral presentations

KEYNOTE

Niche evolution and plant invasions

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After their arrival into a novel region, exotic species must face a number of evolutionary challenges before becoming invasive. Many invasive species adapt surprisingly quickly to the new environmental conditions of their adventive range, such as a new biotic context, new climatic conditions or new disturbance regimes. Thus, a key factor driving a species' invasion lies in its genuine niche characteristics, but especially how evolvable these characteristics are, and how different they are from the ones of native competitors. Thus, the theory of niche conservatism (or lack thereof) provides an insightful framework to understand how the past and contemporary evolution of the niche features of introduced species shapes their future invasive potential. This framework allows discerning which evolutionary factors or scenarios are instrumental to facilitate niche expansion into novel environments, where the demographic cost of negative selection would otherwise be too high to allow population growth – which is the fundamental cause of niche conservatism. Here I will try to elucidate this question with empirical examples. I will show how the study of population genetic processes driving plant invasions and the study of the phylogenetic context of plant invasions into native communities have shed a new light into the evolutionary drivers of plant invasions. As envisioned by Bob Holt almost 10 years ago, invasive species thus offer a invaluable live experiment to test the theories of niche conservatism vs. lability.

Contemporary evolution of *Senecio pterophorus* DC. in response to climate but not to herbivory

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Divergence in plant traits and trait plasticity after invasion has been proposed as an important mechanism favoring invasion success. Current hypotheses predict a rapid evolution in response to changes in the abiotic conditions after invasion, or to changes in the herbivore consumption pressure caused by a decrease in the enemies associated at the area of origin (e.g. evolution of increased competitive ability –EICA– hypothesis). Here we have evaluated, simultaneously, the role of climate and herbivore consumption on the rapid geographical divergence in plant traits and trait plasticity of the exotic plant *Senecio pterophorus* (Asteraceae).

S. pterophorus is a perennial shrub native from Eastern South Africa and a recent invader in Western South Africa (~100 years ago), Australia (>70-100 years ago) and Europe (>30 years ago). In Australia it has been declared a noxious weed subject to eradication. The four distributional regions of *S. pterophorus* differ in their summer drought stress and in their interactions with herbivores. We performed a common garden experiment with plants sampled throughout the entire known distributional area of *S. pterophorus* in the native and non-native ranges to test geographical differences in individual-level traits, leaf-level traits and reproductive-level traits, and their plastic response to water availability.

Native and non-native populations differed in plant traits, but not in trait plasticity, in response to their local climatic conditions. However, our results are contrary to the role of herbivory as a selective factor after invasion.

Keywords: Adaptation; Biological invasions; Drought stress; Evolution of increased competitive ability (EICA) hypothesis; Herbivory; Phenotypic plasticity; Plant traits

Do soil microbes matter in plant invasions? A case study from Australia on five acacias and their associated soil microbial communities across non-native and native range populations

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Although Australian acacias are one of the most notable invaders world-wide, relatively little is known about the role of soil microbial communities in their invasion success both globally and locally. In Australia, acacias have also become invasive or naturalized when introduced into novel locations across states. However, the relative importance of soil biota, particularly beneficial rhizobial and fungal communities, in the invasion success, remains unknown. We comprehensively examined the role of soil biota on the invasion success of four Acacia spp. (*A. cyclops*, *A. longifolia*, *A. melanoxylon* and *A. saligna*) and a close relative *Paraserianthes lophantha* in Australia. Soil and seed samples were collected from respective five native and non-native range populations of each species across four states (i.e. New South Wales, Victoria, South Australia and Western Australia). To assess the role of soil biota on plant performance we used (i) plant-soil feedback experiment to assess the net effect of soil microbiota on plant performance and (ii) 454 sequencing to identify the bacterial and fungal communities in the nodules and soils. Although some variation in microbial composition across the non-native and native populations was found, this did not translate into improved growth in the non-native range suggesting that other abiotic and biotic components (e.g. human imposed artificial selection, herbivory) may contribute more strongly to the invasion success of these acacias in non-native populations in Australia. Interestingly, we found that seed origin had stronger effect on plant performance than soil biota.

Keywords: Plant-soil feedback; Rhizobia; *Acacia*, invasion, Australia

Leaf traits associated with rapid resource acquisition and growth are greater in native than introduced genotypes of an invasive weed

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Leaf structural and chemical traits simultaneously shape plant resource-use strategies and palatability to herbivores. For example, specific leaf area (SLA) and percent N content are positively associated with photosynthesis and palatability, while the opposite is true for leaf dry matter content (LDMC) and C:N ratios. Trade-offs between growth and palatability are important in the context of biological invasions in which introduced populations escape specialist herbivores, potentially selecting for leaf traits that maximize resource use under reduced herbivory. In a common garden experiment we tested whether 13 native European and 18 introduced North American populations of *Verbascum thapsus* exhibit genetic differentiation in SLA, LDMC, N content, and C:N ratios and assessed whether expression of these leaf traits was altered when plants were exposed to or protected from herbivores in the species' native range. Native and introduced plants were genetically differentiated for all traits even after accounting for latitudinal clines in trait expression within each range. Native genotypes had significantly higher SLA and N content than introduced genotypes, while introduced genotypes had higher LDMC and C:N ratios. This characterizes native populations as having a strategy of rapid resource acquisition and growth relative to introduced populations, contrary to expectations. Of the four traits, only SLA was affected by herbivory, with protection from herbivores magnifying the range-level difference in SLA. Plant performance (leaf number and rosette size) was strongly reduced in attacked versus protected plants. Across both treatments, native plants had more leaves than introduced plants, consistent with the findings for the leaf traits. In contrast, introduced plants had larger rosettes: however, a strong negative effect of latitude on rosette size in native (but not introduced) plants makes it difficult to attribute this greater rosette size to post-introduction evolution of increased performance. Thus, on balance, our findings suggest that natives are not intrinsically inferior competitors and indicate a role for environmental factors in shaping previously observed biogeographic differences in the performance of natural *V. thapsus* populations.

Keywords: Plant resource-use strategies; Growth; Palatability; SLA; LDMC

Saprotrophic fungal diversity and abundance during litter decomposition of *Fallopia japonica* and native grassland species

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Fallopia japonica succeeds in invading different ecosystems, because of its peculiar functional traits, especially its huge biomass production which translates into increased litter input. Environmental conditions, litter quality and quantity, and composition of decomposer communities, are the main factors controlling litter decomposition rate. In a field litterbag experiment we observed that slow decomposition rates of *F. japonica* litter are due to its nutritional quality: low N content, high C/N ratio. However, knowledge on how litter characteristics of the invader are related with microbial decomposers is lacking. Therefore, the aims of this work were to characterize saprotrophic fungal communities associated with decomposing litter of *F. japonica* and native grassland litter, and to correlate dynamics of fungal abundance and diversity to litter quality. As decomposition proceeded the overall number of isolated taxa increased, while their abundance decreased. However, diversity and abundance were strongly affected by litter type. No effect of microenvironment of decomposition on fungal abundance and diversity was detected. These results suggest that the low quality litter of *F. japonica* selects saprotrophic fungi. Nevertheless, what appeared from the present study is that, most probably, not species diversity *per se*, but the presence and abundance of particular functional groups drives litter decomposition patterns. Favourable microhabitats (native litters) were preferentially colonized, but less favourable (*F. japonica* leaves and stems) were eventually exploited by specific taxa. Soil legacies left by *F. japonica* via increased inputs of low quality litter and possible changes in saprotrophic mycoflora should be taken into account in eradication and environmental restoration.

Keywords: *Fallopia japonica*; Litter quality; Saprotrophic fungi succession; Decomposition; C/N ratio

Mating system analysis of native and invasive populations of medusahead (*Taeniatherum caput-medusae* (L.) Nevski): evidence for pre-adaptation during biological invasion

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Biological invasions can occur through the introduction of pre-adapted genotypes, post-introduction evolution, or a combination of both. With pre-adaptation, native and invasive populations would exhibit similar patterns of character expression; whereas, post-introduction evolution is associated with differential character expression among native and invasive populations. Medusahead (*Taeniatherum caput-medusae*) is an annual, cleistogamous grass species with a broad geographical distribution across Eurasia. The grass is invasive in six states (California, Idaho, Nevada, Oregon, Utah and Washington) in the Western United States (U.S.). Previous genetic analyses point to the Mediterranean Region, and especially Eastern Europe, as being the geographic origins for this invasion. Using enzyme electrophoresis, we determined the mating system of nine native and ten invasive populations of medusahead using two approaches: the Inbreeding Coefficient (F) method and progeny array analysis. These nine native populations possess at least one of the genotypes that match those detected in invasive populations from the Western U.S. Using the Inbreeding Coefficient method, native populations were found to be 99.8% self-pollinating (selfing) with a 0.2% outcrossing rate and invasive populations were found to be 99.4% selfing and 0.6% outcrossing. Native and invasive populations were both determined to be 100.0% self-pollinating (and 0.0% outcrossing), based on progeny array analyses. These data indicate an extremely high self-pollination rate for both native and invasive populations of medusahead. High levels of self-pollination within native and invasive populations suggest that this selfing mating system may be a pre-adaptation contributing to establishment success and the invasion of medusahead in the Western U.S.

Keywords: Genetic analysis; Invasive grass; Mating system; Pre-adaptation; Post-introduction evolution

Is the proportion of alien species in man-made habitats influenced by city size?

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Plant communities evolving in urban habitats are rich in number of native as well as alien plant species. Still little is known about how the proportion of aliens changes with the size of cities. We assume that city size together with habitat type are among the most important factors influencing species composition and the proportion of alien species in plant communities.

Data sampling was carried in three types of human settlements – cities with more than 100 000 inhabitants, towns with population between 20 to 50 000 inhabitants and villages with less than 5 000 inhabitants. All settlements are situated in Central Europe. In each settlement, three habitat types were chosen – paved settlement centre, residential area and abandoned area with perennial grassland and shrubs. Plots of 1-ha size were sampled in each habitat type by recording all spontaneously occurring taxa of vascular plants. Recorded species were divided according to their origin as native, archaeophytes and neophytes.

We found that total species number in studied habitats is affected by city size. The proportion of neophytes increases with city size especially in residential areas, where human activities serve as a source of propagules of neophytes. In contrast, the proportion of archaeophytes is not dependent on the population size of the city. Archaeophytes are well established part of flora of cities and their surroundings and as such they are not dependent on the repeated human introduction to urban habitats.

Keywords: Archaeophytes; Biological invasions; Central Europe; Neophytes; Urban ecology

Genetic diversity and hybridization in the invasive *Fallopia* complex in its introduced and native range

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The knotweed taxa *Fallopia*: *F. japonica*, *F. sachalinensis* and the hybrid *F.* ×*bohemica* represent a unique model system for the creation of hybrids and the initiation of evolutionary processes in an invaded range. The aim of the study was: (i) to examine the level of genetic diversity in selected populations of *Fallopia* taxa (Poland, Hungary, Ukraine, Slovakia, Japan) in relation to taxon constitution, (ii) to evaluate the number and chromosomal location of rDNA loci, and (iii) to establish genome size and ploidy level in the knotweed species. The results showed the presence of genetic diversity within all taxa, including genetic diversity between individuals of *F. japonica*, in populations from Poland; variation in ploidy among individuals of *F. japonica* and within hybrids was confirmed. Among *F. japonica* individuals octoploids (2*n*=88; 2C=8.48pg) were the ones which dominated while hexaploids (2*n*=66; 2C=6.51pg) dominated within *F.* ×*bohemica* plants. All individuals of *F. sachalinensis* were hexaploids (2*n*=66; 2C=6.01pg). Chromosome identification and emphasis on the dynamics of chromosome re-arrangements is necessary to understand the evolution of *Fallopia* genomes. Hence, a characterization of the number and distribution of ribosomal 5S and 35S rDNA loci, as potential chromosome markers in the genome in invasive knotweeds, is in progress.

Keywords: Knotweed; Polymorphism DNA; Genome size; Ploidy level; Chromosome identification

Maternal environment affects plasticity to salinity of the exotic shrub *Baccharis halimifolia* L. invading estuarine communities

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The invasive potential of exotic plant species in a new habitat depends on their ability to deal with stress. While high stress will prevent the invasion, at moderate stress individual fitness differences can have critical consequences at population level.

Baccharis halimifolia (Asteraceae) is a shrub native to North America which is aggressively invading coastal habitats of Community interest in Southern Europe. It is a plastic species that colonizes sea rush communities with water table salinity levels of 0-30 g NaCl/L.

We explored the tolerance and plasticity to salinity and the role of maternal environmental effects in *B. halimifolia* responses through a salinity gradient (0-20 g NaCl/L) under controlled conditions. We measured fitness and physiological traits in plants grown from maternal lines derived from two sites, halophytic vs. non-halophytic, from an estuary in Spain. Differentiated local adaptation through the estuary is unlikely because this long-lived perennial forms a monospecific continuous population of 25 years old.

Leaves of mother plants from halophytic sites showed sodium ions concentrations two times higher than those from non-halophytic sites, suggesting environmental salinity may affect the plant and seed physiological state. We found almost no mortality at elevated salinity levels, indicating high salinity tolerance, but growth decreased with increased salinity. More importantly, the plasticity of the offspring was affected by maternal environment: at intermediate salinity maternal lines from halophytic sites flowered earlier and produced higher biomass than those from non-halophytic sites, related to differentiated biomass allocation and plasticity of physiological traits (sodium accumulation, stomata density, SLA).

Keywords: *Baccharis halimifolia;* Salt marshes; Salinity; Plasticity; Maternal environmental effects

SESSION 3

BIOLOGY, ECOLOGY, EVOLUTION & IMPACTS OF INVASIVE PLANTS

Posters

Reproductive traits associated with invasiveness in *Bidens frondosa* L. by comparing with a native species, *B. tripartita* L. in Japan

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Bidens frondosa L. is an invasive damaging Compositae in Japan, where occurred its related native species, *B. tripartita* L.. In this study, the reproduction features of the two species, such as the blossom dynamic, seed setting rate and self-compatibility were compared through direct observation and bagging method. The propagation characteristics and the invasiveness of the alien plant were compared to its native relative. The blossom period of *B. frondosa*) is longer than that of period of *B. tripartita*). Six main flower visitors (*Apis ceranajaponica*, *Eristalinus quinquestriatus*, *Episyrphus balteatus*, *Betasyrphus serarius*, *Syrphus torvus* and *Helophilus virgatus*) and up to 403 times' visiting were recorded for *B. frondosa*, while only one visitor, *Xylocopa appendiculata circumvolans*, and only 9 times' visiting for *B. tripartita*. Both species are self compatible, with higher selfing seed setting rates and pollen viability. The seed amount of *B. frondosa* is far greater than that of *B. tripartita* due to its much more inflorescence number per plant. The seeds of two species of plants all have two awns with barbs at their apex. The seed width and bard number of the awn of *B. frondosa* were larger than those of *B. tripartita*. The barbs of the awn of some *B. tripartite* seed deteriorate completely, and some seeds even abandoned their awns. The seeds of *B. tripartita* had lost their adhesive ability to animal hairs and human clothes completely. It is suggested that more inflorescence number, longer blossom period, larger flower display, higher seed yield and larger seed with more barbs are all responsible for the invasive success and expanding distribution of *B. frondosa*.

Keywords: *Bidens*; Invasiveness; Native species

Extreme differences in population structure and genetic diversity for three invasive congeners: knotweeds in western North America

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Japanese, giant, and the hybrid Bohemian knotweeds (*Fallopia japonica*, *F. sachalinensis* and *F. x bohemica*) have invaded the western USA and Canada, as well as other regions of the world. The distribution of these taxa in western North America, and their mode of invasion, is relatively unresolved. Using Amplified Fragment Length Polymorphisms of 858 plants from 131 populations from British Columbia to California to South Dakota, we determined that Bohemian knotweed was the most common taxon (71% of all plants). This result is in contrast to earlier reports of *F. x bohemica* being uncommon or non-existent in the USA, and also differs from the European invasion where it is rarer. Japanese knotweed was monotypic, while giant knotweed and Bohemian knotweed were genetically diverse. Our genetic data suggest that Japanese knotweed in western North America spreads exclusively by vegetative reproduction. Giant knotweed populations were mostly monotypic, with most containing distinct genotypes, suggesting local spread by vegetative propagules, whereas Bohemian knotweed spreads by both seed and vegetative propagules, over both long and short distances. The high relative abundance and genetic diversity of Bohemian knotweed make it a priority for control in North America.

Keywords: AFLP; Bohemian knotweed; *Fallopia*; Giant knotweed; Japanese knotweed

Variation in seed traits and germination potential of *Solanum elaeagnifolium* Cav. following its invasion in Greece

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Solanum elaeagnifolium Cav. (silverleaf nightshade) is a deep-rooted and summer-growing perennial weed of the Solanaceae family. Introduced unintentionally from southwestern USA to Greece on several occasions, the weed is widespread especially on the northern part of the mainland, and is locally extremely abundant. High propagule pressure, including both the size and number of introductions, shaped its genetic structure in Greece and boosted its genetic diversity, a situation which could provide the potential for increased variation in seed traits. The weed produces a large amount of seeds. We asked whether seed production, seed traits and germination potential of this weed are different between two populations of invasive (Greece) and native (Texas) origins. We found that origin had no effect on the fruit diameter and the number of seeds per fruit. Contrary to the trade-offs hypothesis, for both origins it did not appear that the allocations of resources between seed size and number directly competed with each other. However, two phenotypic traits differed between the two origins: Greek seeds were thicker and heavier than Texas seeds. Whereas the germination rate was similar between both origins, the viability of non-germinated seeds was higher in Greek seeds than in Texan seeds, suggesting a higher germination potential of the Greek seeds. We might assume that Greek seeds have a survival advantage over Texan seeds during seedling establishment. Thus, it is more likely that a subset of these seeds will be able to withstand some new and possibly unfavorable conditions, increasing their ability to colonize.

Keywords: *Solanum*; Life history traits; Invasion; Seeds

The response of an invasive weed and its biological control agent under a changing climate of CO_2 enrichment: management challenges for the future

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In this study, we used *Parthenium hysterophorus* L., an alien invasive weed of global significance and *Epiblema strenuana* Walker (a stem galling moth), one of its biological control agents, as a model system to suggest how invasive species and their biological control agents will respond to climate change. *Parthenium hysterophorus*, when grown under an elevated CO_2 concentration (550 µmol mol-1), produced significantly greater biomass, grew taller, produced more branches and 37% more seeds per plant, and photosynthesized at a greater rate, when compared to plants grown at an ambient CO_2 concentration (380 µmol mol-1). The better water use efficiency of parthenium weed under an elevated CO_2 concentration suggest the weed has a greater ability to withstand prolonged periods of drought in the future. *Epiblema strenuana* significantly reduced the height, biomass and seed production of *P. hysterophorus* when grown under both the ambient and the elevated CO_2 concentration. In the presence of the *E. strenuana*, the total seed produced was 30 or 60% less at elevated and ambient CO_2 concentrations, respectively. Moreover, the moth has a negative effect upon seed quality and 45% of seeds produced were found not to be filled. *Epiblema strenuana* had the ability to reduce weed seed quantity and quality, under both the current and a future CO_2 concentration. However under an elevated CO_2 condition *P. hysterophorus* did produce more seeds even in the presence of *E. strenuana*. Manager should be prepared for future increments in invasive potential of weeds and challenges for biological control strategies which are a key component to integrated weed management programs.

Keywords: *Parthenium hysterophorus* L.; Invasive alien species; *Epiblema strenuana*; Seed production

Biotic homogenization of Central European urban floras depends on residence time of invasive species

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Human activities promote the introduction of alien species to new areas and lead to changes in biodiversity. Locally the spread of aliens may increase biodiversity, but at a large scale it may result in biotic homogenization, i.e. increasing similarity among floras of different areas. We examined whether the flora of Central European cities is becoming homogenized because of the spread of alien species, whether the contribution of aliens to homogenization depends on residence time, and whether habitats under more intense human pressure are more homogenized. Using floristic composition data from a standardized sample of 1-ha plots located in seven habitat types in 32 cities in Central Europe, Belgium and the Netherlands, we compared homogenization effects of archaeophytes (pre-AD 1500 aliens) and neophytes (post-AD 1500 aliens). In total, we recorded 1196 plant species. Of them, 562 were native, 188 archaeophytes and 386 neophytes. We found that proportions of archaeophytes and neophytes varied among urban habitats and that archaeophytes contributed to homogenization and neophytes to differentiation of floras among cities, but in general the spread of alien species caused differentiation. Differentiation was low in the most disturbed urban habitats, but was strongest in moderately disturbed habitats. We conclude that biotic homogenization depends on alien plants' residence time. Aliens introduced within the past five centuries are often rare, not yet having achieved their potential range; they therefore increase floristic differentiation. Conversely, species introduced more than five centuries ago have had sufficient time to disperse into most suitable habitats, and consequently contribute to homogenization. Although invasions may therefore initially increase biodiversity, they could ultimately lead to homogenization. These processes are faster and stronger in more disturbed habitats.

Keywords: Alien species; Archaeophyte; Cities; Diversity; Neophytes; Plant communities; Urban ecology

Alterations in microbial community function and nutrient composition in ecosystems invaded by *Acacia dealbata* Link

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A critical outcome on the invasive processes of exotic plants is the impact on soil microbial communities and soil chemical parameters. We studied the impact of *Acacia dealbata* Link on soils of mixed forests and shrublands. We hypothesized that *A. dealbata* can alter soil microbial community function and soil chemical profile in the invaded ecosystems. Two sampling dates were selected depending on the phenological stage of *A. dealbata* (vegetative vs. reproductive)

Soil chemical parameters were deeply modified in the invaded sites. Total C and N, Ca^{+2}, total and available P, Ca^{+2}, Mg^{+2}, NO_3^- and NH_4^+ contents were significantly higher in invaded soils of both mixed forests and shrublands. Soil microbial community activities were affected by the sampling date, soil type and ecosystem. Enzymatic activities mainly varied in soils collected during the vegetative stage of *A. dealbata* in mixed forests and during both, vegetative and reproductive stage in shrublands. Soils invaded by *A. dealbata* showed increased acid phosphatase, β-glucosidase and N-acetyl glucosaminidase activities and the geometrical mean of these activities. Soil basal respiration was significantly reduced in invaded patches of mixed forests.

Our results showed an alteration of soil parameters and microbial community function related to *A. dealbata* presence, probably leading to acceleration in the decomposition and mineralization rates. Additionally, the presence of the invader had different effects depending on the ecosystem studied. Alterations found in the microbial community function, together with changes in soil parameters, indicated that *A. dealbata* produced larger modifications on shrubland in comparison with mixed forest.

Keywords: Plant invasion; Mixed forest; Shrubland; Soil chemistry; Microbial community function; Enzymatic activities

Study of the distribution of genetic diversity of invasive weed *Bunias orientalis* L. at different scales

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We studied genetic diversity and population structure of warty cabbage (*Bunias orientalis* L.) at local, countrywide and regional scale using inter-simple sequence repeat (ISSR) markers. *B. orientalis* is an invasive weed in Central Europe and the Baltic countries. At a local scale, we assessed DNA polymorphism and age structure in single population divided in two subpopulations along a river. We found significant differentiation among subpopulations from the left and the right side of the river, which indicates that gene flow is not sufficient to counteract factors causing genetic differentiation. Our results also show that sexual reproduction predominates in the studied population and seedling recruitment is frequent. Because of this, the population consists of young and genetically different individuals. The aim of study at the country level was to assess the genetic structure of *B. orientalis* in Lithuania and consider the impact of diverse habitats on the partitioning of genetic diversity. The analysis of 19 populations from Lithuania revealed very high genetic differentiation (46 %). However no impact of habitat on genetic differentiation among populations was observed. Our study at a regional scale included 740 individuals of 40 populations from Lithuania, Latvia, Estonia and Poland and showed significant differentiation among populations and among countries. However, most of the genetic variation was partitioned within populations. Highest percentage of polymorphic loci was identified in populations from Poland, and the lowest levels of percent polymorphic loci were detected in populations from Lithuania and Estonia.

Keywords: *Bunias orientalis*; Genetic diversity; Invasive species; ISSR; Spatial scales

Intercontinental comparison of habitat levels of invasion between North America and Europe

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In recent decades several studies on quantitative comparisons of alien species occurrences in different habitats have revealed that habitats differ in their levels of invasion. However, it is still unclear if the invasion patterns observed at regional scale are valid also at larger scales. This study provides the intercontinental comparison of habitat levels of invasion between temperate parts of North America and Europe. Native and alien vascular plant species were identified within 4165 vegetation plots randomly selected from two comprehensive vegetation-plot databases. For 12 corresponding habitats, the levels of invasion were calculated as the proportion of alien species in vegetation plots assigned to a habitat.

A positive relationship was found between habitat levels of invasion between the continents (R^2= 0.908; P< 0.001). On both continents, the most invaded habitats were alluvial forests, riverine fringes and freshwater marshes, whereas the least invaded habitats were mires, waterlogged and mesic coniferous woodlands. Consistent pattern of habitat levels of invasion indicates similar mechanisms influencing the invasion in habitats despite differences in biogeographical and socioeconomic features between the regions. Habitats with high levels of invasion have high resource availability, frequent disturbances, strong human impact and large alien species pool. In contrast, habitats in sparsely populated areas with low nutrient availability, disturbance and limited pool of alien species show low proportions of aliens. At the same time, higher proportions of alien species provided by European habitats to North America than vice versa are reflected in generally higher level of invasion across North American habitats.

Keywords: Alien species; Habitats; Level of invasion; Vegetation-plot database; Invasion pattern

Reproductive potential of *Asclepias syriaca* L.

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The weed *Asclepias syriaca* L. was first detected in Serbia in the 1920s. The plant most frequently occurs in ruderal sites, and it has the ability to spread to adjacent agricultural areas. Studies have been focused on its seed bank ecology, its seed germination dynamics and the influence of the length of vernilization on germination. In 2012 and 2013, we studied germination of *A. syriaca* L. seeds collected from 10 different sites. Soil samples were collected for assessing the composition of the soil seed bank from depths of 0-5 and 5-10 cm. A portion of the seeds were exposed to room temperature and they germinated after 5 days, while other seeds were stored in a refrigerator at 3°C. A portion of the vernalized seeds was placed into moistened sand, and another portion into dry Petri dishes. Vernalized seeds germinated 1, 2 and 3 months after vernalization. Statistically significant differences were detected between the percentage of vernalized seeds that germinated in moist and dry conditions. Prolonged vernilization has a positive impact by increasing the number of seeds that germinated under moist conditions. The seeds of this species that reach the soil decay fast, and the species does not form a persistant seed bank. However, the production of viable seeds in a single season can reach an average of about 1000-9000 seeds per m^2. It can be concluded that beside propagation by rhizomes, seed propagation of this species is significant for its survival and spread.

Keywords: *Asclepias syriaca* L.; Seed bank; Seed germination; Vernalization

Interactions between soil microorganisms and the invasive species *Acacia mearnsii* De Wild. in the north-eastern Algeria

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Soil microorganisms play a key role in the terrestrial ecosystems; they directly affect the development of plants, in a more or less significant way, depending on the plant species. The cork oak, *Quercus suber* L., is one of the most important tree species in Algeria but cork's overexploitation has led to the degradation of cork oak forests. To restore these degraded areas, reforestations with exotic species such as *Acacia mearnsii* De Wild. were made in the 70's. It is from this reforestation stands that *A. mearnsii* started to invade surrounding cork oak trees.

We aimed at analyzing the impact of *A. mearnsii* introduction on composition and functioning of symbiotic microbial communities in the rhizospheric soil of cork oak trees in the El Kala National Park. The analysis of abundance and diversity of symbiotic microflora was carried out by comparing a non-invaded forest soil with a cork oak forest soil totally invaded by *A. mearnsii*. *A. mearnsii* seedlings were grown in the greenhouse on pure cork oak forest soil for 6 and 12 months, and then replaced by cork oak seedlings. Our results showed that soil microbial activity was modified according to the duration of acacia growth, but we did not detect any effects of impacted soils on cork oak plant growth.

Keywords: Invasive plants; Algeria; *Quercus suber*; *Acacia mearnsii*; Catabolic activity; Terrestrial microorganisms

Phytotoxicity variation throughout the development of *Heracleum sosnowskyi* Manden.

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The invasive *Heracleum sosnowskyi* Manden. supress and outcompete native species in natural and semi-natural plant communities changing biodiversity and landscape. In modern ecology the secondary metabolites are considered as significant regulators-mediators in both a plant and an ecosystem. Therefore the study aimed at (i) evaluation of the total phenols content (TPC), phytotoxicity, and (ii) its accumulation in different parts of *H. sosnowskyi* throughout the vegetation. Additionally, the biochemical impact on perennial ryegrass (monocots) and winter rapeseed (dicots) seed germination was assessed in aqueous leachates *ex situ*.

Aqueous extracts of 2-yr old *H. sosnowskyi* exhibited higher phytotoxicity than 1-yr. old plant extracts. The phytotoxic effects of *H. sosnowskyi* aqueous extracts on the germination depended extract concentration (0.02-0.2%), plant age (1-year, 2-year), plant parts (shoot: stem, leaf, blossom, seed; root) and growth stage (rosette-ripening). The plant phytotoxicity was the most strong at flowering stage due to the highest TPC (30.42 mg ml-1). All parts of *H. sosnowskyi* produced phenolics, which inhibited the acceptor-species seed germination.

The results suggested that invasive plant species may acquire spreading advantage in new territories through use of their allelochemicals to inhibit germination. Therefore, it is not only *H. sosnowskyi* giant size, vigorous uptake of nutrients, and reproduction of high seed yield but also biochemical activity that substantially contributes to the success of this invasive plant. The results suggested that invasive plant species may acquire spreading advantage in new land by using 'novel weapons' to inhibit germination.

Keywords: Invasive; *Heracleum sosnowskyi*; Phytotoxicity; Germination

Are differences between populations of *Verbascum thapsus* L. explained by a shift from specialist to generalist herbivores?

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Escape from coevolved specialist enemies is hypothesized to be a central driver of invader success. Evidence for the importance of enemy escape is substantial, leading to the important question: do invaders evolve to become locally adapted to these different enemy regimes? To answer this question, we used a reciprocal transplant experiment to compare 22 non-native North American populations of *Verbascum thapsus* to 14 native European populations. We planted two common gardens: one in non-native range in Colorado (where generalist leaf feeders are dominant) and one in the native range in the Czech Republic (where specialist leaf chewers and root borers are dominant). In each garden, half of the plants were treated with insecticide to reduce insect feeding, allowing us to investigate between-range differences in plant response to herbivory. Our results show that European and North American populations of *V. thapsus* perform differently in both locations, and support our initial prediction that populations have become locally adapted to either Europe or North America since their initial geographic separation. However, predicted patterns of local adaptation only become apparent when comparing within the control plants, which local insect communities were allowed to eat. When grown in Colorado, control plants from North American populations produced more, and larger, seeds than European populations, while the opposite was true for plants grown in the Czech Republic. These data suggest that populations have evolved to become locally adapted to their different enemy regimes.

Keywords: Invasion; Herbivory; Reciprocal transplant experiment

Alien tree invasion into grassland ecosystems: impacts on range land condition and livestock production

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This study investigated the ecological impacts resulting from the invasion by *Acacia mearnsii* De Wild. (black wattle) on South African rangelands, and the subsequent condition of these environments following clearing restoration activities. We located uninvaded, lightly invaded, densely invaded and cleared sites in a grassland ecosystem in the Eastern Cape, South Africa, and examined the impacts of these treatments on forage quality and quantity, and on soil resources. Invasion by *A. mearnsii* reduced grazing capacity by 56% and 72% on lightly and densely invaded sites respectively, whereas clearing improved grazing capacity by 66% within 5 years. Loss of grazing capacity during invasion was largely due to reduction in total basal cover (by up to 42%) and herbaceous biomass (from 5200 to 1200 kg ha-1). Subsequent clearing of invaded sites allowed both basal cover and biomass to return to pre-invasion levels. Soil moisture content was found to be significantly lower on densely invaded sites compared with lightly invaded and cleared sites. Following invasion by black wattle, plant litter increased from 1.3 to 4.2%, the carbon content of the soil increased from 2.0 to 4.0%, and nitrogen concentrations increased from 0.1 to 0.2% in response to nitrogen fixation by the acacia trees. Overall, these changes reduced grazing capacity, from 2 to 8 ha required to support one large livestock unit on uninvaded and densely invaded sites respectively. These findings provide a strong motivation both for preventing further invasions and for clearing existing invasions.

Keywords: *Acacia mearnsii*; Grazing; Livestock; Rangeland

Invasive species of *Bidens* L. in Europe

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Alien species of genus *Bidens* L. have been introduced in botanical gardens of Europe more than once since 18th century. Herbarium collections (LE, MHA, MW, P и KW) confirm that 7 of 13 species have been successfully adapted for new conditions and naturalized (*B. aurea, B. bipinnata, B. connata, B. frondosa, B. pilosa, B.subalternans*, *B. vulgata*). Two species (*Bidens frondosa* and *B.connata*) became invasive in Russia.

For the last decades alien *B.frondosa* eliminated native *B.tripartita* in many plant communities in the Middle Russia. *B.frondosa* characterized by faster seed's germination and longer ontogenesis. Individual plants of *B.frondosa* enter generative period, being seriously larger than ones of *B.tripartita* and they have more lateral shoots and heads (inflorescences). *B.frondosa* undergoes micro evolutional processes within the secondary distribution range. At present, 8 new morpho-types and a few biotypes adapted for different day length are detected in Europe. Therefore, we can predict widening of secondary distribution range together with invasive status' increase for *B.frondosa*.

Majority of European specimens of *B.connata* differ from the type variety (*B.connata* var. *connata*) within the natural distribution range, having no ray flowers in the inflorescence, the first real leaves less narrow than in American specimens, clearly petiolate, with less number of denticles along the margin; denticles big and irregularly located; outer bracts of involucres clearly phylloid, 3-6 cm long. For the first time we proved existence of two types of hairs on *B.connata* achenes: duplex hairs (with long and short cells) and simple multicellular hairs. We consider *B.connata* to be not dangerous for biodiversity of Russian flora for time being.

Keywords: Alien species; *Bidens*; Middle Russia; *Bidens frondosa; Bidens connata*; achenes; duplex hairs; Russian flora

Biomorphology of *Amorpha fruticosa* L. – an invasive species for Russia

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Amorpha fruticosa L. (Fabaceae) is a widely-cultivated shrub, spread from Lipetsk to Krasnodar. About 20 years ago this species “escaped” from culture and at present time it turns into a “transformer” within the southern regions of Russia. It can propagate both by seeds and by root shoots on the sand and steep slopes and in the forest shelterbelts.

A comparative study of the flower’s morphogenesis in two species of *Amorpha* was carried out. Qualitative traits that describe each phase of the flower development were identified. The invasive *A.fruticosa*, as compared to the cultivated *A.paniculata*, has a higher pollen fertility (99%), few larger pollen grains (30×14 microns), higher seed’s germinating (50%), and a more active growth of seedlings.

The fructification of 5 specimens of *A.fruticosa* from Russia was studied. The intraspecific variability of several parameters (the number of fruits, their size, the type of pubescence, the length and shape of calyx teeth, etc.) was shown. A low variability of fruit size (CV≤7%) was noted.

Stomatal types, stomatal density, the distribution of stomata between the abaxial, adaxial epidermis, and stomatal guard cell length was studied as well. Stomas are found on the underside of leaf blades only, its length 15.9-28.3; width - 8.6-17.4 microns.

The chemical analysis of fruits and leaves was carried out. Several microelements (Fe – 44.8, Mn – 34.3, Zn – 30.1, Cu – 9.3, Ni – 2.9, Co – 1.2 и Cr – 0.2 mg/kg) and flavonoids (1.24-1.55%) were determined in leaves. The concentration of these chemical substances in fruits is lower as compared to those in leaves.

Keywords: *Amorpha*; Morphology; Flower’s morphogenesis; Stoma; Microelement; Flavonoid

Alien flora of Natura 2000 sites in Greece: species richness and site characteristics

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Protected areas are designed to conserve natural landscapes, to protect biodiversity and key ecosystem processes, to provide ecosystem goods and services, and occasionally to contribute significant economic benefits. Most studies have found that PAs contain fewer invasive species than their surrounds. However, new forms of land use are added, and as PAs are becoming increasingly isolated in a mosaic of human-altered landscapes, reverse trends are frequently also reported.

In this study we assess the influence of environmental properties on alien plant species richness. Data from 141 Natura 2000 sites in Greece, characterised as SCI, or SCI/SPA, were investigated, and in total, 70 alien plant species from 31 different families were found. In a generalized linear model analysis, alien species richness and various frequency indices were used as measures of the invasibility of each site, while several site eco-geographic characteristics were used as predictor variables. Geographic parameters included elevation, area, perimeter and site coordinates, whereas climatic parameters included a series of temperature and precipitation variables. The occurrence of alien species was significantly affected by site elevation, along with site perimeter and latitude. This trend specifies two classes of environmental properties associated with habitat vulnerability to invasions: one bioclimatic and a second one biogeographic that are both connected to propagule pressure and anthropogenic disturbance.

Keywords: Alien Plants; Protected areas; Habitat invasibility; Environmental properties

Invasion of *Cenchrus longispinus* (Hack.) Fernald in E Europe: attack of clones

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Cenchrus longispinus (Hack.) Fernald is a noxious annual weed in S European Russia and Ukraine, spreading along railways, roads, and sandy areas on the Black Sea shore and inland. Crop fields and sea- and riverside recreation areas are equally prone to infestation with this spiny grass. AFLP analysis of local populations of this species sampled from Poland and Italy through Ukraine to Volgograd reveals an extremely low level of genetic diversity. Infrapopulation variability is usually completely lacking, what probably indicates to apomictic mode of propagation. Nevertheless, local populations from geographically proximate localities tend to group together in NJ analysis. The results are corroborated by the Bayesian analyses in Structure 2.2. We argue that several independent invasions to Ukraine and Russia have occurred since the first appearance of *C. longispinus* in S Ukraine in 1954. Some of them were more successful than the others, and lead to a wider spread of putatively apomictic clones to areas distant from the original place of the invasion.

Keywords: Invasive plants; *Cenchrus longispinus*; AFLP; Apomixis

The complete chloroplast genome sequence of black nightshade (*Solanum nigrum* L.)

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Black nightshade (*Solanum nigrum* L.) of Solanaceae is a plentiful and troublesome weed of agricultural and horticultural fields and gardens. It belongs to the highly variable group of the Morelloid clade and its closest relatives are found in the Dulcamaroid clade in the phylogenetic scheme of the genus *Solanum*. Black nightshade exhibits a high level of variability and several sub-species have been identified.

In recent years the available plastome sequence of weeds species is increasing offering new option to weed genetics and genomics. Here, we report the complete sequence of the *S. nigrum* chloroplast (cp) genome based on Illumina sequencing. The size of this circular genome is 155,725 base pairs (bp), with an average AT content of 62.14%. It contains 114 genes and conserved open reading frames (*ycf*s). Comparison with the previously sequenced plastid DNAs of Solanaceae reveals patterns of plastid genome evolution in the Solanaceae family and identifies varying degrees of conservation of individual plastid genes. In addition, we discovered a region possessing pseudogenic repeats in *S. nigrum* trnL-F spacer, which will provide powerful tool for population genetic analyses.

This chloroplast genome is the first sequenced weed plastome in the genus *Solanum* outside Potato clade. The chloroplast genome sequence of black nightshade will provide helpful genetic tools to conduct population studies and help to shed light on the genetic and evolutionary mechanism of this species.

Keywords: Genome evolution; Next generation sequencing; Solanaceae; Weed genetics

Impact of invasive *Oenothera glazioviana* Micheli on the composition and structure of a coastal dune native plant community.

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Invasive species are considered one of our top global conservation issues. It is well known that these species cause negative impacts on ecological systems, including loss of biodiversity and long-term changes in the composition and function of native ecosystems. One of the potential impacts of invasive plant species can be the disruption of existing co-evolved interactions among native species.

Coastal dune habitats, considered as priority natural habitats by the European Habitats Directive, are particularly vulnerable to plant invasion. The spread of exotic invasive species and their potential impacts on the structure and function of coastal dune plant communities has been recently recognized and remains poorly explored. We assessed the impacts of the invasive *Oenothera glazioviana* Micheli, an introduced species currently spreading in the coastal dune habitats of Northern Spain, on the structure of the native plant community. We used null model analysis to ask if there are native species that tend to co-occur or not with *O. glazioviana* at small scale, and whether the co-occurrence patterns among natives differed between invaded and non-invaded habitats. We used C-Score as a quantitative index of community organization.

Preliminary results suggest the existence of negative interactions between *O. glazioviana* and certain native species, such as *Euphorbia paralias,* and positive interactions with other native species, such as *Ononis ramosissima*. Our results also suggest that community disassembly might be taking place in the presence of *O. glazioviana* at small spatial scales. These disruption processes may have important implications for community dynamics and functioning in invaded ecosystems.

Keywords: Impacts; Community assembly; *Oenothera glazioviana*; Null models

Impacts of the exotic trees *Ailanthus altissima* (Mill.) Swingle and *Robinia pseudoacacia* L. on litter fall patterns and soil nutrients in riparian forests of Central Spain

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Litterfall is an important energy transfer in an ecosystem. The quantity, quality and timing of litterfall widely depends on the species plant community. Invasion by exotic trees imply changes in the species composition that may alter nutrient cycle via litterfalls. Riparian forests are hightly susceptible to plant invasion due to its mild climatic conditions, high nutrient availability and the gaps created by human activities. We compared leaf litter nutrients, temporal patterns of litterfall, nitrogen (N) and phosphorous (P) inputs and soil nutrients between paired patches of non-invaded forests (dominated by *Populus alba* L. or *Fraxinus angustifolia* Vahl*)* and forests invaded by the exotic trees *Ailanthus altissima* (Mill.) Swingle and *Robinia pseudoacacia* L. in central Spain riparian forests. Litterfall was monthly collected during two years (2011-2013), sorted into leaves, flowers, fruits and twigs, dried (60°C; >48h) and weighed. Our results showed no differences in total annual litterfall, N-P soil inputs or soil nutrients between invaded and non invaded patches. However the timing of litterfall and N and P inputs showed additional peaks in summer in the invaded patches as compared to the non-invaded ones. These peaks coincided with a greater summer leaf and flower litterfall of the exotic trees than that of natives. Differences in the seasonal litter inputs may alter life cycles of detritivores that are in synchrony with native litterfall timing and consequently modify soil decomposition rates. Additionally, summer peaks of exotic litter may affect seed establishment and germination of some plant species which finally may change plant community structure.

Keywords: Nutrient cycle; Ecological impacts; Litterfall

Growth rate and seed production of *Pueraria lobata* (Will.) Ohwi in southern Switzerland

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Pueraria lobata (Will.) Ohwi, (Fabaceae, hereafter called Kudzu) belongs to the world's 100 worst invasive alien plants, having an extraordinary growth rate of up to 30 cm per day and the capability of significant vegetative reproduction. In the southernmost part of Switzerland, Kudzu is present since two decades, favored by in its mild sub-mediterranean climate. Naturalization has occurred in 33 known locations within a nearly 3'000 km2 area in Canton Ticino. In order to study growth rate and sexual reproduction of the species, we analyzed basic growth parameters and seed germination rate according to the ISTA protocol under greenhouse conditions simulating temperature ranges between 10 to 25°C and 15 to 30°C at the Agroscope research station in Cadenazzo, Switzerland. Daily growth rates resulted slightly lower (14 cm /day) compared to observations reported worldwide. On the contrary, seed germination resulted to be considerably higher than described in the literature so far. Depending on sample origin and age of the seeds, germination rates ranged from 28% to 88%. In the suboptimal lower temperature range, germination took longer but reached analogous rates two weeks later. Similar to previous studies we found a relation between seed weight and germination rate (r2 = 0.68), heavier seeds showing higher germination rates.

Our results contribute to give a broader picture of the invasive potential of Kudzu. Considering ongoing climatic changes, a greater attention should be given to seed productivity and dispersal ability of the species.

Keywords: Invasive Alien Species; Reproductive Success; Germination; Growth Rate

Some morphophysiological parameters of generative parts of Lithuania populations of Himalayan balsam

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Since long time physiology and biochemistry of alien balsams is a subject of wide investigations. *Impatiens glandulifera* Royle is an invasive plant with impressive big flowers. Most studies are performed in Central and Western parts of Europe, till now more detailed information about this species in more northern European countries is missing. The aim of present study was to evaluate elemental composition of *I. glandulifera* flowers and to estimate morphometric characteristics of *I. glandulifera* seeds and pollens collected from various Lithuania sites differing in geography and habitats. Nitrogen concentration was estimated by Kjeldal method. For the other element assessments plant flowers were digested in the closed vessel microwave system. The determinations of metal (Mg, P, K, Al, Fe, Zn, Cu, Mn, Cd, Ni) concentrations were performed by flame and graphite furnace atomic absorption spectrometry. The concentrations of phosphorous were determined colorimetrically. Pollen and seed morphometric parameters were estimated under scanning electron microscope. The obtained results showed that the mean values of elements concentrations (µg/g d.m.) in flowers of *I. glandulifera* were as follows: K – 3009.2; Mg – 2913; P – 295.9; Fe – 115.08; Al – 21.66; Mn – 32.52; Zn – 70.68; Cu – 10.84; Ni – 6.35; Cd – 0.77. Measurements of *I. glandulifera* seed morphologic characteristics showed that the size of seeds ranged in the interval 2.6–3.9 mm, intervals for width, perimeter, area were respectively 1.7–3.2 mm, 7.4–11.4 mm, 3.9–9.1 mm^2. Significant differences between populations were found according to most parameters. Relations between morphometric parameters and element concentrations will be discussed.

Keywords: *Impatiens*; invasion; alien plants; element; AAS

Comparison of allelopathic effects of invasive in Baltic region *Impatiens* and neighbouring species

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One of the mechanisms explaining successful spread of invasive plants might be their ability to generate allelopathic compounds. *Impatiens parviflora* and *Impatiens glandulifera* are among the most spread invasive plant species in Baltic States. In present study, we compared allelopathic effects of the leaves of *I. parviflora* and *I. glandulifera* and neighbouring species, *Urtica dioica*, *Phragmites communis*, *Galium aparine*, *Stellaria media*, *Rubus caesius*, *Alnus glutinosa*, *Galium aparine*, *Epilobium hirsutum*, *Geranium robertianum*, *Alliaria petiolata*, *Calystegia sepium* and *Geum urbanum*. For evaluation of the plant effects solutions of locally growing *Juglans regia* were included into experiment. *Lepidium sativum* is very often used for allelopathic surveys. Seeds of garden cress were germinated in the water extracts of listed plants. Extracts of two other invasive species, *Erigeron annuus* and *Helianthus tuberosus* were also assessed. Initial aqueous extracts of the plant leaves were prepared using 1 g of dried mass of the leaves, extracted in 10 ml water within 12 hour period (further called dilution 1:10). Germination of seeds in the water was assumed as a control (100 %). Leaf extracts of all examined species had depressive effects on *Lepidium sativum* germination and architecture of the seedlings. Undiluted extracts of *Impatiens glandulifera*, *Epilobium hirsutum*, *Phragmites communis* and *Alliaria petiolata* failed to germinate. The extracts of *Erigeron annuus* and *Helianthus tuberosus* caused germination ranging between 1 and 2 %, germination of *Impatiens parviflora* was similar to *Juglans regia* and ranged between 9 and 10 %, the effects of the other species were intermediate.

Keywords: Balsaminaceae; Germination; Growth; *Lepidium sativum*; Community structure

Population variability of weedy sunflower based on seed morphological traits

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During 2013, five weedy sunflower (*Helianthus annuus* L.) population were observed at locations across Southern Srem and Southern Banat (Serbia). At each site, twelve plants were studied and three flower heads were collected from each plant at maturity. Eleven morphological traits of weedy sunflower seeds were observed and analyzed (colour of seed, presence of dots and strips, colour of the strips, strip position, seed shape, seed length, width and thickness, mottling of the seed and length of the hairs).

Seed length was between 5.3 and 6.3 mm, width between 2.4 and 3.0 mm while the thickness of seeds ranged from 1.37 to 1.59 mm. Gray colour of seeds was most common (60% of the total), followed by brown (20%), black (10%), white (8%) and red (2%). Generally, seed shape was ovoid with greater or lower presence of hairs and dots depending on the population, while the hair length ranged from 288 to 392 μm.

Observed populations expressed major variability in monitored traits, which was confirmed using t-test. Plants from the three sites had traits that are closer to volunteer plants- such as the lower mottling of the seed (on a scale 1-3), greater length, width and thickness of the seed. At the other two sites the plants were characteristically similar to the sunflower wild type (smaller sized seeds).

Keywords: Population variability; Weedy sunflower; Seed parameters

SESSION 4

INVASIVE PLANT MANAGEMENT: BIOLOGICAL AND INTEGRATED CONTROL

Session Chair: Paul E. Hatcher, Mounir Mekki & René Sforza

SESSION 4

INVASIVE PLANT MANAGEMENT: BIOLOGICAL AND INTEGRATED CONTROL

Oral presentations

KEYNOTE

Integrated Weed Management: the use of biological control of weeds in agricultural and natural environments

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Biological control of weeds, in the assumption of "a deliberate use of natural enemies to reduce the density of a particular weed to a tolerable level", is generally considered as an alternative to traditional management approaches, based on the use of chemical and/or agronomic methods. Moreover, the objective of biological weed control is not eradication but simply the reduction of the weed population to an economically low level: small populations of the weed must always be present to assured the survival of the associated biological control agents.

Vice versa, the goal of an integrated weed management system (IWM) is to integrate biological control approaches, strictly correlated to long-term effects in time and space, with more immediate and localized strategies, finalized to a prompt and confined suppression of weed populations through multidisciplinary methods, associated with a prompt restoration with native plants species.

Weed management can be separated into 2 distinct categories: broad –spectrum vs. narrow-spectrum actions, both extremely important when considering the development and implementation of IWM strategies in divergent habitats such as rangelands and cultivated fields.

The achievement of a prolonged suppression of target weeds populations in a specific agro-ecosystem, it is also depending on quality of existing habitats, water and other natural resources.

In a framework of a sustainable agriculture and environmentally friendly issues, an Area-Wide territorial strategy in Integrated Weed Management is evaluated, taking under consideration combinations and eventual synergisms between biological control methods and mechanical, chemical and biotechnological management practices, applied throughout the growing season.

Keywords: Biological control; Integrated weed management; Sustainable agriculture

LIFE+ Project Estuaries of the Basque Country: *Baccharis halimifolia* L. management and monitoring in the Atlantic coast

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Baccharis halimifolia L. invades subhalophilus sea rushes, reedbeds, salt prairies and coastal heathlands in the Atlantic coast of France and Spain. From 2010 to 2014 the Basque Government performed a LIFE+ project in three estuaries of the Basque Country (Spain) where more than 300 hectares of the invasive shrub were removed combining different mechanical and chemical methodologies. A monitoring plan was implemented to measure the impact and effectiveness of the project. 45 permanent plots and 164 transects were set up, where data as resprouting, number of seedlings and cover of native species were collected. After three years of monitoring, the results show different responses of the invasive species according to the characteristics of the invaded environment. They also show that native habitats are recovering the invaded area, especially in the main invaded estuary, the Biosphere Reserve of Urdaibai. There, the 40% of the invaded area have been covered by reedbeds of *Phragmites australis*, 18% by sea rushes of *Juncus maritimus* and 9% by salt prairies of *Elytrigia atherica*. These are important habitats for protected birds as *Acrocephalus paludicola* and others. However, *B. halimifolia* is still resprouting in some areas. In the other two estuaries there has been no regrowth, but very high seed germination. The learning's from this project have been compiled into a management handbook that has been worked in a multidisciplinary and international group composed of experts and managers of the affected regions in the European Atlantic coast.

Keywords: *Baccharis*; LIFE+; Estuaries; Monitoring; Handbook

The combined effects of defoliation by a biological control insect and a suppressive fodder plant upon the growth reproductive potential of invasive parthenium weed

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Parthenium hysterophorus L. is an invasive plant species native to South and Central America that has become a significant problem of natural and agricultural ecosystems around the world. In Australia, 11 biological control agents have been released since 1980s to manage this weed. Some agents have a significant impact upon weed populations but not all agents have established throughout the range of this weed in Queensland where it is still a problem in pasture production regions. The supplementary management is therefore, required to complement the classical biological control. Under shadehouse conditions, we tested the combined effect of a leaf feeding beetle (*Zygogramma bicolorata* Pallister) and a suppressive pasture plant, butterfly pea (*Clitoria ternatea* L.) upon the growth and reproductive potential of *P. hysterophorus*. *Clitoria ternatea* was found to suppress the growth of weed, both in the presence and in the absence of *Z. bicolorata,* However, its suppressive ability, as measured by the suppressive index, was greater in the presence of *Z. bicolorata* then in its absence. *Clitoria ternatea* alone reduced the biomass and height of weed by 34% and 15% however when *Z. bicolorata* was present the biomass and height of parthenium weed were further lowered by 49% and 37%, respectively. Similarly, butterfly pea alone reduced the total seed production up to 54% and 95% when *Z. bicolorata* was added. Interestingly, *Z. bicolorata* alone reduced the seed production up to 90%. The results suggest that the biological control agent can work additively with suppressive pasture plant to bring about enhanced management of parthenium weed.

Keywords: *Zygogramma bicolorata*; Plant competition; Herbivory; *Parthenium hysterophorus*; Integrated weed management

Ecology and biological control of Blackberry: an unexpected result from south western Australia

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We have assessed over ten years the ecology and biological control of alien invasive blackberries of European origin (*Rubus anglocandicans* A.Newton and other *Rubus* species included in the *Rubus fruticosus* complex) in the biodiversity hot spot of south west Australia. Blackberries in this part of Australia are mainly found along river banks where they cause about a 50% loss of biodiversity. In 2004 new strains of the biological control agent, the rust fungus *Phragmidium violaceum* originally collected from a trap garden near Montpellier, France, were released, but without improved control. However, the most dramatic impact was the discovery of a new disease complex, called blackberry decline. First observed in 2007, the decline syndrome is only recorded from *R. anglocandicans* and currently is restricted to the Warren and Donnelly catchments in Western Australia. The disease is associated with *Phytophthora* species (including the new species *P. bilorbang*). Riparian zones along river valleys, about 100 m wide, were previously filled with an impenetrable understorey of blackberries to 3 metres high. The decline disease devastates the blackberry populations with only a few plants remaining. We report on progress towards identifying the causes of blackberry decline and the results of the measurement of impact on blackberry populations. The removal of blackberry potentially opens the riparian environment to other invasions and an ecosystem restoration project has started. Part of the ecosystem restoration project includes quantifying the effects of grazing, shading and revegetation, assessing the ecology and longevity of blackberry seeds, and studies of the disease complex.

Keywords: Biological control; Blackberry; Ecosystem restoration; *Phytophthora*; Riparian

Dispersal, impact and use of three fortuitously-arrived parasites in the control of invasive exotic plants in Valencia

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Two of the most widespread invasive species of the Valencia region (Spain), *Opuntia maxima* Mill. and *Agave americana* L. and the recently arrived *Azolla filiculoides* Lam. are seeing their populations visited by fortuitously arrived parasites presumably: *Dactylopius opuntiae* (*Hemiptera*; *Dactylopidae*), *Scyphophorus acupunctatus* (Coleoptera; Curculionidae) and *Stenopelmus rufinasus* (Coleoptera; Curculionidae), respectively. The three insects have had different impacts on host plants and progressed at different rates across the territory. *S. rufinasus* has colonised 6 wetlands in less than 1 year along a coastal strip of 80 km and curbed *A. filiculoides* populations from 16 occupied ha to a relictual presence. *D*. *opuntiae* invasion has progressed at a rate of 30km per year since 2009, leading *O*. *maxima* to local extinction. Finally, *S*. *acupunctatus* shows the lower rate of dispersal, despite the flying ability of adults. Nevertheless, the mortality of infested plants is high. The regional government of Valencia has started to use *D*. *opuntiae* for the control of the biggest infestations of *O*. *maxima*, located in the coastal sandstone natural parks of Calderona and Espadán. In the latter park *D*. *opuntiae* has been introduced at two sites in June 2013. Results show an initial expansion rate of 5 m per month with evidence of clear visual damage (chlorosis and necrosis) within 6 months. Further introductions will be carried out during 2014. The use of *D*. *opuntiae* represents the only possibility to control *O*. *maxima*, which is the worst invasive species of sandstone areas and one of the biggest conservation threats for these habitats.

Keywords: *Dactylopius*; *Stenopelmus*; *Scyphophorus*; *Opuntia*; *Agave*; *Azolla*; Biological control

Status of biological control projects in California on terrestrial invasive alien weeds

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At least 33 invasive alien weed species have been targeted for biological control in California, primarily in regions that have a Mediterranean climate. These weeds originated mostly from Europe and western Asia. Species that have been successfully reduced include: *Carduus nutans* (musk thistle), *Centaurea diffusa* and *C. squarrosa* (diffuse and squrarrose knapweeds), *Chondrilla juncea* (rush skeletonweed), *Hypericum perforatum* (St. Johnswort), *Salvia aethiopis* (Mediterranean sage), *Senecio jacobaea* (tansy ragwort), and *Tribulus terrestris* (puncturevine). Research is ongoing for: *Acroptilon repens* (Russian knapweed), *Arundo donax* (giant reed), *Centaurea solstitialis* (yellow starthistle), *Crupina vulgaris* (common crupina), *Cytisus scoparius* (Scotch broom), *Delairea odorata* (Cape-Ivy), *Genista monspessulana* (French broom), *Linaria dalmatica* (Dalmatian toadflax), *Onopordum acanthium* (Scotch thistle) and *Salsola tragus* (Russian thistle). Fifty-eight agents (including insects, mites and rust fungi) have been permitted for introduction, of which at least 36 have been released and 29 are well established.

Keywords: Biological control; Invasive alien weeds; California

Is biological control a solution to the international impacts of South African fireweeds; *Senecio madagascariensis* and *S. inaequidens*?

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South African *Senecio* spp. *Senecio inaequidens* DC. and *Senecio madagascariensis* Poir. (Fireweed, *Seneçon du Cap*) are internationally important weeds in Europe, Australasia, and the Hawaiian Islands spread around the world on the sheep's back. They cause major impacts to grazing land and upland grasslands used for grazing and are also a significant weed of perennial horticulture and roadsides. Both weeds are very similar really only being distinguishable easily by genetic sequencing. Both come from the KwaZulu-Natal region of South Africa where the genus is still evolving. The first is a more high altitude over 1000m and the second is more Mediterranean/subtropical and more of an annual in habit. Hawaii and Australia have been undertaking a biological control program for some time on these weeds with various levels of success. This paper reviews these efforts and considers the value feasibility and likelihood of success of this approach for managing the weed globally including in Europe.

Keywords: *Senecio*; Weed management; Biological control feasability

Biocontrol of South American aquatic weeds: international cooperation and in situ agent assessment in Argentina

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Many of the most problematic aquatic weeds in the world are native to the main South American water catchments: the Orinoco, Amazonas and Paraná/La Plata basins. The FuEDEI, in Hurlingham, Argentina (formerly USDA-ARS-SABCL) has a long-standing history of research on many of these weeds, including waterhyacinth, cabomba, Brazilian elodea, alligator weed, floating pennywort, waterlettuce, *Azolla*, giant salvinia, and water primroses. Currently, selecting biocontrol agents for weeds presents more challenges than the mere determination of specificity. In this talk we show some of the most interesting problems faced by our scientists in dealing with some of these challenges. Biogeography and genetic studies of alligator weed have been taken on to determine factors behind the suitability of some of its natural enemies. Field ecology studies have allowed us to determine the key natural enemies and abiotic factors behind population fluctuations of Brazilian elodea (*Egeria densa* Planch.) and floating pennywort (*Hydrocotyle ranunculoides* L.f.). The feeding impact of two sap-sucking insects, one of waterlettuce (*Pistia stratiotes* L.), and another of waterhyacinth (*Eichhornia crassipes* (Mart.) Solms) was evaluated in semi-field conditions. The probable interaction between the waterlettuce sap-sucker and another biocontrol agent (*Neohydronomus affinis*) was also assessed in the field. With these experiments we sought to give answers to some of the most pressing problems in biocontrol science: is an agent specific? If it is, will it adapt to the invaded area? If it does, will it produce an impact on the target weed? And finally, how will it interact with other biocontrol agents already present in the environment?

Keywords: Weed biocontrol; Agent selection; South American weeds

Biological control of non-native weeds in Europe: a piggy-back ride into the future

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Over the last decade classical biological control (CBC) has received increased attention in Europe. CBC constitutes an environmentally friendly, sustainable and less labour intensive approach than methods of manual or chemical control, the latter often being unacceptable in riparian systems. Regulatory drivers for biocontrol include the Sustainable Use Directive which promotes non-chemical alternatives to pest management, the Water Framework Directive requiring all waterbodies to reach "good ecological status" and the imminent Invasive Species Regulation.

The release of the psyllid, *Aphalara itadori*, against Japanese knotweed, *Fallopia japonica*, in 2010 marked the first ever official classical biocontrol release against an invasive weed in Europe. However, "inundative classical" biological control is common practice in the UK against the highly invasive water fern, *Azolla filiculoides*, using the weevil *Stenopelmus rufinasus* with great success. These projects are both highly applicable to Europe, indeed *S. rufinasus* is already present in a number of countries in western Europe offering the potential for augmenting weevil populations for *Azolla* biocontrol.

This presentation will review the situation of aquatic and riparian weeds being targeted focussing on progress with Japanese knotweed and outlining collaboration success with North America where an application for release of the psyllid is receiving favourable reviews. Recent work for the Netherlands on knotweed piggy-backed the UK programme clearly demonstrating the potential for European collaboration in more enlightened countries. Potential future target invasive weeds will also be considered, including *Ludwigia* sp. which is well established in parts of Europe and *Solidago* sp.

Keywords: Classical biological control; Europe; Japanese knotweed (*Fallopia japonica*), Floating water fern (*Azolla filiculoides*); *Aphalara itadori*; *Stenopelmus rufinasus*

SESSION 4

INVASIVE PLANT MANAGEMENT: BIOLOGICAL AND INTEGRATED CONTROL

Posters

Preventing plant invasions during grassland restoration: resource-driven suppression by competition with small- and large-seeded seed mixtures

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The invasion of alien species contributes to ecosystem degradation and complicates efforts to restore degraded systems. The design of communities resistant to invasive alien species (IAS) plays a key role for restoration. One important aspect determining the biotic resistance of the target community is related to the "limiting similarity" theory, which predicts that IAS will be unlikely to establish if there are natives with similar traits present. This study focused on the early stage of restoration; here seed size was the most suitable trait because it is correlated to the amount of resources in the seed, to seedling size and relative growth rate. Additionally, we analyzed if relative seed density of native species affected biotic resistance. A greenhouse experiment with two treatments was devised, i.e. community seed mass (small and large), seeding density (high and low), invaded by a large- or small-seeded IAS (*Ambrosia artemisiifolia* and *Solidago gigantea*). The results showed that small-seeded native mixes at high density were effective in suppressing both large and small-seeded IAS, due to the effect of higher density of individuals and thus competition for resources and space. Seed size trait was not decisive in terms of suppression as the experimental design showed only density-dependent suppression, and differences in seed size of the IAS were only visible the first 2 months translating into tall plants of *Ambrosia artemisiifolia*. Future study should include additional plant traits that might contribute to competitive interactions during establishment of IAS.

Keywords: Biotic resistance; Integrated management; Habitat restoration; *Ambrosia artemisiifolia*; *Solidago gigantea*

Molecular genotyping as a tool to manage invasive ryegrass (*Lolium* spp.) in South Africa

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Ryegrass (*Lolium* spp.) is an invasive weed of small grain production areas of the Western Cape, South Africa. Ryegrass hampers effective and profitable crop production. Recently a number of weed resistance cases have been studied at the DNA level. The primary advantage of DNA-based tests for herbicide resistance is a yes/no answer for a specific mutation which confers resistance to a particular group of herbicides with the same mode of action and can be obtained within 48 hours. The aim of this study was to screen a number of ACCase and ALS codon amino-acid substitution mutations to determine if PCR-based tests can be used to speedily and accurately identify herbicide resistance in invasive ryegrass in the South African wheat industry. DNA extracted from green leaf material was quantified, followed by dCAPS PCR and specific restriction enzyme digests. Samples were run on a 2% Agarose gel at 100 volts for three hours. Digital photos were taken and allele sizes visually compared and scored against a 100bp molecular weight ladder. The two most occurring mutations identified were the ALS 197 mutation, which confers high levels of resistance to sulfonylureas and triazolopyrimidines and low levels of resistance to imidazolinones and the ACCase 2078 mutation, which confers resistance to all aryloxyphenoxypropionates herbicides and all cyclohexanedione herbicides (including Clethodim). Research concluded that the PCR-based test for detecting ACCase and ALS herbicide resistance in ryegrass is proving to be fast and accurate in determining the resistance status of invasive ryegrass biotypes.

Keywords: *Lolium*; Herbicide resistance; ACCase

Potential for active integration of chemical and biological control tactics for control of waterhyacinth, *Eichhornia crassipes*

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Waterhyacinth (*Eichhornia crassipes* (Mart.) Solms) is the most intensively managed floating aquatic weed in Florida, USA, primarily through applications of herbicides like 2,4-D. Approximately $3.4 million US was spent in Florida during 2011-2012 to conduct maintenance control of floating aquatic weeds in public waters. Thus, even a small reduction in the amount of herbicide needed for maintenance control of waterhyacinth could represent significant long-term savings for Florida resource managers. The additive effects of chemical and biological control on waterhyacinth were evaluated using two levels of insect biocontrol: 1. Control (no biocontrol agents) and 2. Biocontrol (unrestricted herbivory by *Neochetina eichhornia* Warner (Coleoptera: Curculionidae), *N. bruchi* (Hustache) (Coleoptera: Curculionidae), and *Megamelus scutellaris* Berg (Hemiptera: Delphacidae), with three rates of 2,4-D: 1. Control (no herbicide), 2. Low rate (2.1 kg ha^{-1} a.e.), and 3. Operational rate (4.3 kg ha^{-1} a.e.). The experimental design was a 2 x 3 full factorial with five replications arranged in a completely randomized design. Testing was conducted in 30 uncaged concrete mesocosms (surface area 1.6 m^2) at the USDA-ARS Invasive Plant Research Lab in Davie, Florida. Initial results indicated that plant populations sprayed at both rates of 2,4-D recovered quickly in the absence of herbivory by the biological control agents, but not when biological control agents were present. In the latter case, the low rate of 2,4-D was as effective as the high rate.

Keywords: *Neochetina eichhornia*; *Neochetina bruchi*; *Megamelus scutellaris*; 2,4-D; biocontrol

The biological control of *Impatiens glandulifera* Royle using the rust pathogen *Puccinia komarovii* var. *glanduliferae*

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Himalayan balsam (*Impatiens glandulifera* Royle) is a highly invasive annual herb, native to the western Himalayas, which has spread rapidly throughout Europe since its introduction as a garden ornamental. The plant can rapidly colonise riparian systems, damp woodlands and waste ground where it reduces native plant diversity, retards woodland regeneration, outcompetes native plants for space, light and pollinators and increase the risk of flooding. Current control methods are fraught with problems and often unsuccessful due to the need to control the plant on a catchment scale. Since 2006, CABI and our collaborators have surveyed populations of Himalayan balsam throughout the plants native range (the foothills of the Himalayas, Pakistan and India) where numerous natural enemies have been collected and identified. Agent prioritisation, through field observations and host range testing has narrowed the potential candidates down to the rust pathogen, *Puccinia komarovii* var. *glanduliferae*. This autoecious, monocyclic pathogen shows great promise, not only due to its impact on the host but also due to its high specificity as observed in the field and preliminary host range testing. The aecial stage infects the hypocotyl of young seedlings as they germinate through leaf litter containing teliospores. This initial infection severely warps the structure of the developing plant

This paper will review the research conducted to-date, including a molecular comparison of *P. komarovii* var. *glanduliferae* with other closely related species, the life cycle and infection parameters of the rust, its host specificity, and an up-date on the current situation regarding the potential release of this biocontrol agent.

Keywords: Himalayan balsam; Biocontrol; Host range testing; Lifecycle evaluations

The role of gall formers as biological control agents of the broad-leaved paperbark tree *Melaleuca quinquenervia* in Florida (USA)

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The Australian broad-leaved paperbark tree, *Melaleuca quinquenervia* (Cav.) S.T.Blake, is a serious weed in wetland systems of Florida USA. This tree was introduced in the late 1800's as an ornamental and greatly expanded its range causing significant environmental and economic damage. It also threatened environmentally sensitive areas such as the Florida Everglades whose habitat was highly favourable to the rapid growth of *M. quinquenervia*. In 1984 a classical biological control program commenced to find agents in the native range of this tree along the east coast of Australia. Among more than 450 insect species that were found to feed on *M. quinquenervia* and its close relatives, gall formers were discovered that damaged mature trees, saplings and seedlings. Cecidomyiidae and Fergusoninidae flies, gall-forming Eriococcidae scales and Eriophyiidae mites were all evaluated for their potential as biological control agents. The fly, *Fergusonina turneri*, which forms galls in a mutualistic association with nematodes, was released in 2005 but failed to establish after multiple attempts. The stem-galling fly *Lophodiplosis indenata* (Diptera: Cecidomyiidae) was released in 2008 and rapidly established causing extensive damage, particularly to sapling and seedlings, and has contributed to the successful control of *M. quinquenervia*. Another three *Lophodiplosis* species are being evaluated in case further control measures are required.

Keywords: Biocontrol; Florida Everglades; Gall formers

The effect of temperature on several aspects of the biology of *Eccritotarsus catarinensis*, a biological control agent for water hyacinth in South Africa

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Water hyacinth (*Eichhornia crassipes* (Mart.) Solms), which is widely distributed from its origin in South America throughout tropical and subtropical regions of the world, is the most damaging aquatic weed. The bug *Eccritotarsus catarinensis* Carvalho (Hemiptera: Miridae) has been released as a biological control agent against water hyacinth in South Africa.

The effectiveness of weed control agents is often influenced by local temperatures, which can determine both their distribution and performance. We evaluated the responses of *E. catarinensis* to three constant temperatures (20, 25 and 30ºC) using a laboratory culture of insects that originated from Peru and reared at 25ºC. Development time, longevity, reproductive output and sex ratios were recorded at each temperature for two consecutive generations.

Development time was faster at 30ºC. Adult longevity and reproductive output were significant reduced at 30ºC comparing with 25 and 20ºC in the two successive generations. In contrast, sex ratio was not affected at 30ºC. Second generation individuals reared at 20 and 25ºC performed as well as those from the first generation. In contrast, few adults that had developed at 30ºC laid eggs that hatched.

In conclusion, *E. catarinensis* presented different phenotypes depending on temperature. We demonstrated the capacity of some individuals to adapt to the extreme temperature, however, this adaptation accompanied with decrease in fitness traits and may reduce the efficacy of biological control program.

Keywords: Biological control; *Eccritotarsus catarinensis*; Temperature; Water hyacinth

Growth and physiological changes in *Amaranthus deflexus* L. seedlings due to herbicides and water stress

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The research aimed to evaluate the influence of water deficit on growth of *Amaranthus deflexus* L. after application of herbicides with different modes of action. The experimental design was completely randomized. Treatments were a factorial combination of five herbicide treatments (2,4-D, Diuron, Nicosulfuron, Glyphosate and control 'water') and three soil moistures (100%, 60% or 30% of field capacity), with four replicates. The treatments were assessed at 0, 2, 4, 6 and 8 days after the treatments (DAT) according to their efficacy, plant height and stem diameter. Herbicides were the most effective at severe water stress at 4 DAT. The herbicides 2,4-D, Glyphosate, Diuron and Nicosulfuron were efficient in controlling *Amaranthus deflexus* in all water conditions. The Diuron has just increased the degradation of chlorophyll a and b. There was a decrease on growth quantitative parameters due the application of herbicides and interaction with water stress.

Keywords: Pigweed; Osmotic adjustment; Antioxidant enzymes

Europe: a generous provider of weeds for Australia

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Among the 2912 naturalized alien plants species in Australia, 1050 (36%) are native to Europe, the 3rd largest source continent after Africa and Asia. A small fraction of those plants introduced from Europe have caused major problems in their new range in Australia because of the similarity of the climate and the lack of natural enemies.

Many of southern Australia's most important agricultural weeds are of European origin (e.g. *Lolium rigidum*, *Raphanus raphanistrum*) and cause over A$2 Billion of costs each year in crop and pasture production losses. Similarly some of those European invasive plants are important environmental weeds (e.g. *Cytisus* spp.) that dominate some native ecosystems in the Australian National Parks.

In response to these impacts, CSIRO European Laboratory in Montpellier has organized explorations in Europe throughout the geographic distribution of the European plants, mainly in Mediterranean areas, in order to select the specific biological control agents for introduction into Australia to try to suppress these weeds. From 1970 to 2006, 35 insects and 4 fungi species selected as biological control agents were introduced into Australia following rigorous risk assessment against the targeted European plants belonging to the families Asteraceae, Boraginaceae, Clusiaceae, Fabaceae, Lamiaceae, Polygonaceae, Rosaceae, etc.

Monitoring conducted in the field in Australia confirmed the establishment of most of the biological control agents and the complete or substantial control of 17 of these targeted European invasive plants. Quite a lot of this work has been done in collaboration with other agencies with similar problem weeds in their countries

Keywords: European invasive plants; Australia; Biological control

Searching for a control strategy against Yellow Nutsedge (*Cyperus esculentus* L.)

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Yellow nutsedge a *Cyperaceae* species, propagates exclusively with tubers in the ground. Its abundance in Switzerland has largely increased in the last 20 years, due to changes of land use and important difficulties to control. The species is not well known to farmers yet, and tubers are increasingly displaced by vehicles machines, root crops and with shoes. Infested fields are not mapped yet. Effective strategies to control the weed in the sense of reducing tuber production and therefore reducing contamination of neighboring fields are still missing. Agroscope started recently a trial program for development of control strategies. A legal obligation to announce foci and to control would help farmers, contractors and purchasers of crops to coordinate actions for preventing tuber production and displacement.

Keywords: *Cyperus esculentus*; Changes of land use; Invasive weed; Weed management; Herbicide incorporation; Tuber count

Targeted chemical control of *Pueraria lobata* (Will.) Ohwi depending on age and expansion of the plants

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The mild climate of our region encourages the establishment of invasive neophytes, topic of increasing interest in the southern part of Switzerland. Particularly *Pueraria lobata* (Will.) Ohwi (Fabaceae, Leguminosae) has found a suitable habitat to express its full potential. *Pueraria lobata* (Kudzu) occurs in the canton Ticino territory since more than two decades and in the last years we have observed an augmentation of 39% of the infested area with new outbreaks of the recorded areas. These locations are not monitored by authorities despite the plant's presence in the black list of invasive species of the Swiss Commission for Wild Plant Conservation CPS/SKEW which determines that establishment and spread should be prevented.

Considering the environmental risk of this invasive species, it is very important to implement short-term practical solutions to control the expansion of Kudzu in our area. In 2012 a working group composed by different stakeholders has been created to put into practice different strategies to control this invasive within the park area of the Monte Verità location. The tests were oriented mainly on chemical control: treatments with different herbicides on infested surfaces with shoulder pump, plant by plant treatments with different herbicides with hand pump and plant to plant injections of herbicides with syringe and brush. Each treatment has been studied for the different caracteristics of outbreaks. The results showed excellent efficiency up to 100% with some active agents. From October 2013 further tests with chemical free procedures are in progress for areas where chemical treatments are not allowed.

Keywords: *Pueraria lobata*; Chemical control; Practical solutions

Protecting endangered Cuban UNESCO-protected areas from invasive species: the case of marabou

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Marabou (*Dichrostachys cinerea* Wight & Arn.) is a thorny, acacia-like, fast-growing woody bush which invades fields, wasteland, roadsides and other disturbed areas. This gregarious species has become a very aggressive invasive weed in Cuba, where no native predators or pathogens are found. In the Trinidad Valley (an UNESCO-protected area in Cuba Central), it forms veritable forests in areas where sugarcane growing has been discontinued. A preliminary study using readily available preemergence herbicides has been carried out in order to elucidate the best treatments rendering maximum and persistent weed control with minimum herbicide rate and environmental stress. The effect of three herbicide treatments (diuron, metribuzin, and pendimethalin) at five different herbicide rates (x1/8, x1/4, x1/2, x1, and x2 of the field rate) were tested under laboratory-controlled conditions. Pregerminated seeds were planted in batches previously treated with herbicides. Mortality and plant regrowth after treatment were recorded 28 DAT. The process was cycled four times to test both effectiveness and herbicide persistence. Dose-response assays showed that metribuzin and pendimethalin results in terms of mortality and regrowth inhibition were just fair at full herbicide rates of higher, with an average persistence of only 28 days. Diuron treatments were much more effective, displaying good weed control even at 1/4 rates during the first 28 days. This effectiveness lasted up to 84 days at full and double herbicide rates. As a preliminary conclusion, diuron preemergence treatments seem the best effective and persistent option to control marabou in sugar cane-infested areas of the Trinidad Valley.

Keywords: Preemergence; Marabou; Diuron; Persistence; Caribbean

Characterization of retention and transfer of protein labels in the saltcedar leaf beetle for use in ecological studies

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Understanding dispersal and predator-prey associations of biological control agents can lead to a better understanding of the ecological services that they provide. Marking arthropods with labels facilitates studies of their activity in nature, and thus provides new insight into biological traits relevant to pest suppression. Here we describe labeling studies on different life stages of *Diorhabda carinulata* (Desbrochers) (Coleoptera: Chrysomelidae), an important biological control agent of saltcedar. We used immunoglobulin G (IgG) protein solutions to determine if: 1) externally-applied IgGs are effective labels of the various life stages of *D. carinulata*, 2) IgGs can be retained between its life stages, 3) the addition of a biological solvent (dimethyl sulfoxide [DMSO]) enhances IgG retention, 4) DMSO-IgG labels transfer via feeding from marked *D. carinulata* to its predator, *Perillus bioculatus* (F.) (Heteroptera: Pentatomidae), and 5) abiotic factors associated with field conditions mediate label retention. Duration of immunolabels was measured on eggs and larvae in the laboratory, and on adults in laboratory and field studies. Overall, our results indicate that protein marking technology would be useful for studies of dispersal and predator-prey associations of *D. carinulata*, and suggest potential for use in other weed biological control systems.

Keywords: Immunolabels; Saltcedar; *Tamarix*; Dispersal; Predator-prey associations; *Diorhabda*

Natural enemies of perennial pepperweed, *Lepidium latifolium* L., in its introduced range

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Perennial pepperweed, *Lepidium latifolium* L., is a member of the Brassicaceae native to Eurasia. It was unintentionally introduced to North America in the early 1900s, where it has since spread over millions of acres. This weed is an aggressive invader of wetlands, meadows, roadsides, and agricultural fields where soil conditions are slightly alkaline or saline. Control of this weed presents a challenge: physical and chemical control strategies are generally not effective and have adverse consequences. Biological control is also problematic, due to the relatively close phylogenetic relationship between *L. latifolium* and cruciferous crops (e.g., broccoli, cabbage, canola) and several native *Lepidium* species, which could also be impacted by an *L. latifolium* biological control agent. However, foreign exploration in regions where perennial pepperweed co-occurs with other *Lepidium* species may nevertheless yield promising candidate agents. A better understanding of the natural enemy complex of perennial pepperweed in its introduced range would help guide future control efforts because it would characterize current levels of suppression, help identify existing natural enemies that might be enhanced, and determine the potential for interference, or perhaps synergistic effects, between candidate agents and natural enemies that are already present. Results of a 3-year study in Nevada and California showed that perennial pepperweed is attacked by several above-ground natural enemies, including weevils, flea beetles, leafhoppers, and white rust. Herbivore attack on *L. latifolium* roots was rare. Site-specific differences in natural enemy attack were observed. Our results provide baseline information that will aid foreign exploration and agent selection.

Keywords: *Lepidium*; Natural enemies

Can biocontrol offer a solution to invasive ginger beauties?

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Hedychium J.Koenig or wild ginger species, are tall, showy and fragrant perennial herbs, once highly prized and extensively cultivated throughout Europe's "hot houses" in the nineteenth century. As a result of global trade, a number of species were transported to warmer climates and have subsequently escaped cultivation and become naturalised across the world. Originating in the eastern Himalayan foothills, *Hedychium gardnerianum* Sheppard ex Ker Gawl. in particular has become an aggressive colonizer of indigenous, undisturbed forest habitats in its introduced range.

Two agents have been prioritised for study for Hawaii and New Zealand: a shoot fly, *Merochlorops dimorphus* which has only ever been recorded from the target in the field and which stunts the plants and prevents flowering, as well as a large, conspicuous weevil, *Tetratopus sp.*which has a wider feeding host range within the Zingiberaceae in the lab but which only completes its development on *Hedychium* species in tests carried out thus far. Both species have a protracted life cycle with only 1-2 generations per year which has complicated rearing efforts and complementary studies are being instigated in the field in India.

A review of the project to date is given with details of the specificity studies as well as prospects for release in Hawaii and New Zealand and opportunities for European stakeholders to join the international consortium and piggy-back the research.

Keywords: *Hedychium gardnerianum*; Biological control

Growth, leaf nutrient contents and carbon isotope discrimination during artemisinin-induced stress in *Arabidopsis thaliana* (L.) Heynh.

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Natural products from microbes and plants offer a broad array of molecules with great diversity in their structures and biological activity that can be utilized in weed management, either directly as a natural product-based herbicide or indirectly as an allelochemical produced by a crop or cover crops. Artemisinin, a potent antimalarial drug, is phytotoxic to many crops and weeds. We reported here, the effects of artemisinin on plant growth, leaf nutrient contents and carbon isotope discrimination in *Arabidopsis thaliana* (L.) Heynh. Arabidopsis ecotype Columbia (Col-0) seedlings were grown in perlite and watered with 50% Hoagland nutrient solution. Adult plants of *Arabidopsis* were treated with artemisinin (at 0, 40, 80, 160 µM) for one week. Carbon isotope compositions analysis was performed and values were expressed in ‰ according to the procedure described by Hussain et al. (2011). Leaf protein content was determined by Bradford's method according to Pedrol and Ramos (2001) using spectrophotometer and bovine serum albumin as standards.

Exposure of *Arabidopsis* to different concentration of artemisinin caused reduction in leaf fresh weight that was 40% less than the control plants. Artemisinin (160 µM) significantly decreased the carbon and nitrogen contents in *Arabidopsis* leaves. Artemisinin increased the sodium, potassium and phosphorus contents and there was no reduction in hydrogen, aluminum and copper contents in *Arabidopsis* leaves. Carbon isotope composition values were less negative (–35.82, –35.87 and –35.28) following treatment with 40, 80 and 160 µM artemisinin, respectively, than control (–36.88). Artemisinin decreased the leaf protein contents in *Arabidopsis* at all concentration.

Keywords: *Arabidopsis*; Secondary metabolites; Stable isotopes; Leaf nutrients; Protein contents

Potential for classical biological control of two non-native aquatic weeds in Europe: *Crassula helmsii* (Kirk) Cockayne and *Hydrocotyle ranunculoides* L.f.

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Crassula helmsii (Kirk) Cockayne (Australian swamp stonecrop) and *Hydrocotyle ranunculoides* L.f. (Floating pennywort) are both troublesome weeds in the UK, and are becoming problematic in other parts of Western Europe. Introduced through the aquaculture trade from Australia and South America respectively, these non-native species have become invasive in many vulnerable aquatic habitats, smothering native plants and altering the surrounding ecosystem. The introduction of the Water Framework Directive requires European waterways to attain 'good ecological status', a goal that is compromised by invasives such as these. Conventional control is a major challenge for several reasons, including the restrictions of chemicals in or near waterbodies, and the prolific vegetative growth of these plants that can be promoted by manual control. Research into the biological control of invasive plants such as *C. helmsii* and *H. ranunculoides*, as a long-term sustainable solution for their management, has been funded by the UK Government to help achieve the aims of the Directive.

Surveys in each of the plants' native ranges have revealed many natural enemies, which have been narrowed down to a small subset that have potential as biological control agents. In Australia, a stem-mining fly (*Hydrellia perplexa*), an Eriophyid mite (*Aculus* sp.) and a *Colletotrichum* pathogen have been found causing significant damage to *C. helmsii*, and are currently being safety tested in quarantine. Similar testing is underway on a weevil (*Listronotus elongatus*), fly (*Eugaurax* sp.) and rust pathogen (*Puccinia hydrocotyles*) for *H. ranunculoides*. The research to date will be presented, and each agent's potential for control discussed.

Keywords: Biological control; Invasive; Europe; *Crassula helmsii*; *Hydrocotyle ranunculoides*

Biology and management of invasive grass *Arundo donax* L. in Mediterranean ecosystems

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Knowledge of the peculiarities of the biology and ecology of *A. donax*, such as the presence of its perennial underground storage organs, is fundamental for the successful elimination of reeds. The sensitivity of *A. donax* to different control methods vary throughout the year depending on their physiological state. It has been suggested that if a particular method is applied inappropriately, it may contribute to the unwanted spread of this species or even encouraging the consolidation of their populations. In this regard, it should be noted that the various methods that can be employed to remove this reed - chemical, physical, mechanical and creating competition - differ in their effectiveness, impact on the environment and implementation costs. The method of control is dependent on different variables which include: legal regulations, the characteristics of the plant, the location of the intervention, whether it is possible to repeat the process in subsequent years.

This presentation is a review of aspects of the biology of the invasive species in relation to the methods of disposal. These are analyzed in terms of cost, effectiveness and impact on the environment, in order to establish the best practice for implementation.

Keywords: Giant reed; Invader; Riparian ecosystem; Remove; Biology

Successful biological control of weeds in Europe: the case of Russian thistle (*Salsola tragus* L.) and the facultative saprophyte *Colletotrichum salsolae*

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Salsola tragus L. is a problematic weed in Greece and the western USA. It is a biological control target. In the present study, the establishment in the field of a *S. tragus*-specific, native Greek, pathogen *Colletotrichum salsolae* was monitored, after artificial inoculations, in two regions in Greece. The purpose of the research was to demonstrate the effectiveness of this fungus to control the weed and to determine disease progress in relation to weather events. The isolate of *C. salsolae* used in the studies was isolated from diseased *S. tragus* plants in Chalkidiki, Greece. The fungus was grown in rice substrate containing rice, V8 juice and CACO3. Three experimental fields, one in Serres and two in Kozani, Greece, consisting of 4-6 plots each, were established in 2006 and 2010, respectively. Placement of about 300g of the rice inoculum once, in late summer, in the center of each plot in all three disease-free experimental areas, resulted in rapid spread of the disease with maximum incidence at about 40 days after inoculation, in all experimental fields. The progress of disease incidence, and disease severity, was correlated with cumulative rainfall. By two years after inoculation, Russian thistle had been eliminated from the Serres site and one field in Kozani. In the other Kozani field, Russian thistle density declined to 0-25% from original densities of about 80% in large areas of the field. This study demonstrates the potential of *C. salsolae* as a successful biocontrol agent, and introduces a simple, low-cost method to control Russian thistle.

Keywords: Biological control; *Colletotrichum salsolae*; Russian thistle; *Salsola tragus*

Successful biological control of weeds in Europe: the case of creeping thistle (*Cirsium arvense* (L.) Scop.) and the rust pathogen *Puccinia punctiformis*

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Creeping thistle (*Cirsium arvense* (L.) Scop.) is a problematic weed in Greece and the rest of Europe. The purpose of this research was to test a proposed disease cycle for the biological control rust pathogen *Puccinia punctiformis* and to demonstrate a method for successful epiphytotic establishment, mimicking the disease's natural cycle. The following disease cycle was investigated: I) Systemically infected shoots bearing spermagonia emerge in spring. II) Spermagonia cross-fertilize to produce aeciospores which infect nearby healthy leaves. III) Infections by aeciospores result in uredinia formation. IV) Uredinia transition to telia in mid- to late-summer. V) Telia-bearing leaves abscise, fall, and are blown onto newly emerging rosettes in autumn VI) Basidiospores from germinating teliospores infect the rosettes, and the fungus grows into the root system where it survives the winter and subsequent seasons. VII) Systemically infected root systems, give rise to systemically diseased shoots next spring. To confirm this hypothesis *C. arvense* leaves, bearing telia of *P. punctiformis,* were collected from a field in Kozani, Greece. These leaves were used to inoculate young *C. arvense* rosettes in autumn 2010, in a disease-free field in Kozani. Systemically diseased shoots emerged adjacent to inoculation sites the next spring, indicating successful inoculations take place during autumn. The percentage of inoculations leading to emergence of a systemically diseased shoot averaged 22.5%, but was as high as 40%. Recent research on presence of the rust in roots indicates that success in disease establishment was probably much higher. The experiment was successfully repeated besides Greece in Russia, New Zealand and USA.

Keywords: Biocontrol; *Puccinia punctiformis*; Disease cycle

Alien invasive weeds of Spain and suggested biological control programs to tackle the problem

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As a country situated in the Mediterranean region, Spain is highly exposed to introduction of alien, invasive species from Africa and as a member of European Union and according to the rules for free movement of goods and persons it can hardly control it's boarders from possible introduction of dangerous species entered other EU countries from all over the world. Alien invasive species already invading the country put in danger the sensitive eco systems of southern regions and has a negative impact on the economy of the country in many regions. A study showed that only in Valencian community there are 49 invasive weeds, which put in danger the flora and fauna of this area. These weeds disturb the balance of the sensitive ecosystem or affect the production of agricultural goods. In many cases they are widely spread which makes the use of herbicide and other control methods not viable. Here we would like to suggest the use of biological control for reducing the spread and control of six of these weeds, which seem to be of a higher importance for the country. These are 1. *Lantana camara* (Common lantana) 2. *Cortaderia selloana* (Pampas grass) 3. *Solanum elaeagnifolium* (Sliverleaf nightshade) 4. *Penicetum setaceum* (Fountain grass) 5. *Arundo donax* (Giant reed) and 6. *Carpobrotus edulis* (Ice plant). Most of these are native to Africa or America. The mentioned weeds are problematic in other Mediterranean countries and could be subject to a wider project involving many other regions facing the same problem.

Keywords: Mediterranean region; Alien invasive species; Biological control; ecosystem

New Zealand's biosecurity response system in action; black-grass (*Alopecurus myosuroides* Huds.) a regulated organism

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The New Zealand Ministry for Primary Industries (MPI) is entrusted with growing and protecting New Zealand's primary industries by maximising export opportunities, improving sector productivity, increasing sustainable resource use and protecting New Zealand from biological risk. The Ministry recently introduced a 'single system' to respond to all organisms and goods that pose a biosecurity risk to New Zealand's economy, environment, human health and social culture. This biosecurity response system is being used in mid-Canterbury, New Zealand to manage a spillage of black grass seed (*Alopecurus myosuroides* Huds.), a highly invasive weed of cereal crops. Since A. myosuroides is not present in New Zealand the establishment of black grass poses a serious threat to New Zealand's arable farming community and export industry.

In collaboration with local government and industry, MPI is leading this response using the single response system to ensure this pest weed does not establish in New Zealand. An overview of the black grass response will be discussed and demonstrate how the single response system applies for an active case.

Keywords: *Alopecurus myosuroides*; biosecurity risk; cereal crops

Investigating host specificity of *Ustilago phrygica* and impact for biological control of *Taeniatherum caput-medusae* (L.) Nevski

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Taeniatherum caput-medusae (L.) Nevski, with common name medusahead rye, originates from Eurasia and has been reported from Portugal to Russia and Kazakhstan. It is mainly distributed in countries surrounding the Mediterranean Sea, including Greece. The weed is noxious in many western U.S. states and is a biocontrol target. The smut fungus *Ustilago phrygica* is a natural enemy of the weed in the Balkan region. The impact of the fungus on controlling medusahead rye was investigated. The fungus was evaluated in a field trial, for its effectiveness to kill the plant at maturity. Host specificity on 8 crop species and 14 grasses belonging to the Poaceae family was also tested. Field surveys were conducted in several regions of Greece in order to record other diseases and isolate new pathogens of the weed. In the field trial, artificial inoculations with *U. phrygica* were successful but resulted in low infection rates of *Taeniatherum caput-medusae*. Apart from medusahead rye, 2 other species namely *Bromus tectorum* L. and *Sorghum bicolor* (L.) Moench. produced smutted spikes. *Aegilops, Agropyron, Elymus* and *Hordeum*, previously reported genera to host this pathogen, were not infected under our field conditions. Low infection rate together with rare appearance of the disease in field surveys, led to the conclusion that this pathogen is not a major enemy of medusahead rye in nature. During field surveys several other collar and root rot fungi were isolated from diseased plants. The pathogenicity of the fungi isolated, and their impact in minimizing the population size of medusahead rye is under investigation.

Keywords: *Taeniatherum caput-medusae*; Noxious weed; *Ustilago phrygica*; Biocontrol

Biological control of introduced European musk thistle in the Southern Appalachians, USA: a 25-year assessment of benefits and risks

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Twenty-five years ago, an integrated management program, focusing on classical biological control using two herbivorous weevils, *Rhinocyllus conicus* and *Trichosirocalus horridus*, against an introduced European plant, musk thistle (*Carduus nutans* L.), was initiated in the southern Appalachians, USA. This state-wide, multi-agency program was embraced by farmers, landowners, urban dwellers, state agencies, federal agencies, extension personnel, etc. In 1991, with funding from state and federal agencies, this program expanded regionally into the southern Appalachians (southeastern USA - Georgia, North Carolina, Tennessee, and Virginia [where releases began in 1970s]). Farmers and the citizenry continue to benefit from this program, as thistle densities have declined (as much as 90%), contributing to significant economic savings to farmers, landowners, and state/federal agencies (e.g., Tennessee Department of Transportation saves about one million dollars annually in reduced costs for labor and materials for herbicide applications and mowing). Although benefits are extensive, potential risks (environmental concerns and impacts on non-target native thistle species) exist. Studies in other areas (USA) documented *R. conicus* and *T. horridus* feeding on non-target, native *Cirsium* species. Research in Tennessee did not document *R. conicus* on naturally-occurring native thistles; however, field-cage studies demonstrated potential for *R. conicus* to use several native thistles as hosts. Several non-target native thistles supported populations of *T. horridus* in Tennessee. After 25 years, this program continues to be successful, with little negative impacts. This paper provides a 25-yr assessment of benefits and risks of biological control as part of an integrated management program against musk thistle in the southeastern USA.

Keywords: Weed biological control; Classical biological control; IPM; Musk thistle; Weevils

Invasive European plant species in the Southern Appalachians, USA: potential targets for collaboration and cooperation in a new beneficial insects quarantine laboratory

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Exotic plant and animal species are easily transported throughout the world, both intentionally and accidentally. Often, these transportations result in introductions and establishments of new species, which may become problematic in their new country. Many examples of pest species that were introduced in this manner are found throughout the world. Plant and insect species from the USA have become established in Europe and European species have become established in the USA. Several introduced and established European plant species have become serious economical and environmental weed problems in the southern Appalachians (southeastern USA). These include musk thistle (*Carduus nutans*), bull thistle (*Cirsium vulgare* (Savi) Ten.), multiflora rose (*Rosa multiflora* Thunb.), purple loosestrife (*Lythrum salicaria* L.), spotted knapweed (*Centaurea stoebe* subsp. *micranthos* (Gugler) Hayek), oxeye daisy (*Leucanthemum vulgare* Lam.), poison hemlock (*Conium maculatum* L.), European privet (*Ligustrum vulgare* L.), and others. Growers, homeowners, and state/federal agencies expend time, labor, and resources to manage these introductions. One management alternative is biological control, which may provide area-wide weed reductions. In 2013, a new Beneficial Insects Quarantine Laboratory was approved at the University of Tennessee, Knoxville (USA). This Quarantine Laboratory is equipped to receive, evaluate, and assess biological control agents of established introduced weeds in the southern Appalachians. The goal of the Laboratory is to identify and select potential biological control agents for release and management of invasive weeds. To reach this goal, we are seeking cooperators and collaborators in Europe. This poster details potential targeted invasive species in the southern Appalachians, describes the Beneficial Insects Quarantine Laboratory, and examines mutual benefits for cooperators.

Keywords: Assessment; Classical biological control; Quarantine Laboratory

Invasive plants management in Russia: control and measures against their spread (as for example - *Cenchrus longispinus* (Hack.) Fernald)

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Invasive plants management in Russian Federation is ensured by the National Phytosanitary Service of Russia - Rosselhoznadzor. Initially analyse of the phytosanitary risks in case of penetration of some weeds in the country are conducted. The List of quarantine objects of Russian Federation is approved as a legal document and use for a control above noxious plants by the Phytosanitary Service. *Cenchrus longispinus* (Hack.) Fernald is one of newcomer alien plant species, included in the List. This is an annual grass (Poaceae), having spikelets, fused in total spiny burs and contained of 1-4 seeds. Originally *C. longispinus* were registered in the port of Novorossiysk in Krasnodar region in 1976. Now the weed is diffusely spread in the four regions of Russia, grows in most cases along the railroads, on sandy soils, ruderal places, on branch of rivers and embankments. To control above *C.longispinus* and prevent further spread to other habitats need to next activities:
1- phytosanitary control to prevent of penetration seeds and spiny burs of *C. longispinus* across state boundaries (check of plant materials, seeds, feed, etc);
2- to carry out annual monitoring activities in territories where *C.longispinus* were registered and estimate to increase their numbers there;
3- improvement of methods for identification of *C.longispinus* from other non-quarantine species similar to this plant due to morphological as well as molecular genetic methods.

Keywords: Invasive plants; Phytosanitary risks; *Cenchrus*; Rosselhoznadzor

SESSION 5

COMMON RAGWEED: TOWARDS SUSTAINABLE MANAGEMENT SOLUTIONS FOR EUROPE

Session Chair: Heinz Müller-Schärer & Bruno Chauvel

This session is co-organized by COST Action FA1203 Sustainable management of *Ambrosia artemisiifolia* in Europe (SMARTER)

SESSION 5

COMMON RAGWEED: TOWARDS SUSTAINABLE MANAGEMENT SOLUTIONS FOR EUROPE

Oral presentations

KEYNOTE

Accidental introductions of classical biological agents against invasive weeds in Europe - the ragweed leaf beetle as a case study

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Classical biological control is a well-established tool for the sustainable management of invasive alien plant species, but up to date it has received far less attention in Europe than on any other continent. However, the number of studies documenting economic and/or ecological impact of invasive alien species (IAS) in Europe is steadily increasing. In the new EC Regulation on IAS due to come out soon, Member States will be obliged to act on IAS, and biological methods to control IAS are specifically mentioned.

Hence, there is a growing list of invasive plant species that are targeted for classical biological control in Europe. Besides the normal step-wise procedure of a) pre-release studies to assess the risks of releasing a specialist biological control agent (BCA), b) a science-based decision process by competent authorities whether or not to release a BCA, and c) a post release monitoring of the impact of a deliberately released BCAs, we are also confronted with an increasing number of accidentally introduced organisms that could potentially be used as classical biological control agents. Using the example of *Ophraella communa*, a leaf beetle which is used as a biological control agent of *Ambrosia artemisiifolia* in China and which has recently established in Europe, I will propose a rapid risk-benefit assessment that will help regulatory bodies to decide on how to respond to accidental introductions of potential BCAs.

EU-COST Action on 'Sustainable management of *Ambrosia artemisiifolia* L. in Europe (SMARTER)': a template for future weed science initiatives

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Ambrosia artemisiifolia L. is both a major weed in European agriculture and a declared flagship invasive alien species (IAS) for Europe, the latter mainly due to its particularly large production of highly allergenic pollen generating huge medical costs. It thus not only ideally qualifies as a "bridge-building species" for the present symposium on weeds and invasive plants, but also has the potential to serve as a model weed species to fuel a rebirth of "sunset" weed science (as perceived by European policy-makers and politicians) by capitalizing on "sunrise" invasion science.

SMARTER (2013-2017) already has more than 180 researchers from 33 countries with specialists in weed research, invasive alien species management, ecology, aerobiology, allergology and economics as registered participants, constituting a truly trans-national and trans-sectoral cooperative network. It aims to initiate and develop long-term and sustainable control methods with focus on biological control and vegetation management, to integrate these into existing mechanical and chemical control measures, and to quantify the success of these measures for both agriculture and health. SMARTER will allow the various stakeholders to select optimal habitat- and region-specific combinations of control methods.

I will describe the structure and the state of the Action, and illustrate its innovative potential with a few studies typical of the Action's strategic orientation. We expect SMARTER to contribute to sustainably reducing the abundance and spread of ragweed in Europe to the benefit of agriculture and human health, but hopefully also to a more sustainable niche for weed science.

Keywords: Common ragweed; Cooperative network; Invasion science; Sustainable control methods

Common ragweed national maps & public policies in France

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Common ragweed (*Ambrosia artemisiifolia* L.) has been detected in France in the middle of the XIXth century. It has spread throughout the territory during the XXth century with a critical evolution. Public policies have not been able to contain this spread at the moment, and it is now difficult to find ways to tackle the invasion. Publication of national and regional maps seems to be an effective tool to draw up an overview of the situation and build management strategies. With a set of historical and modern data collected all over the French territory, and from many different stakeholders, we consider the progress of the species in time. The system of legislation applied locally is analyzed with regard to the data of presence of the species. Several examples of maps are proposed, which aim at determining thresholds of intervention. The reliability of the results is analyzed in the light of the pressure of sampling.

Keywords: Invasive plants; Common ragweed; Distribution maps; public policies

No performance reduction at the present northern edge of *Ambrosia artemisiifolia* L. invasion range

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Plant populations at range edges may exhibit reduction of performances and fitness. In the case of biological invasions, such a reduction could be associated with a slowing down of the spread and explain the non-naturalization of a species outside its present invasion range. Common ragweed (*Ambrosia artemisiifolia* L.) is an ideal model to investigate such processes, since it is invasive in France but not naturalized in northern countries, such as Belgium and the Netherlands. In this study, we test if the performances of ragweed populations vary among different invasion zones.

Three populations were selected in each of four invasion zones in Western Europe: 1) French invasion area; 2) northern and 3) southern invasion edges; and 4) outside the invasion area (Belgium and Netherlands). Field performances (growth, reproduction, stress resistance) were recorded on 25 plants per population. Furthermore, the competition by the native flora was assessed around each plant. Generalized Linear Models were used to compare performance among invasion zones and populations, with competition as covariate. Regressions were also performed to assess the influence of climatic data on population performances.

No evidence of decreasing performances was found at the edges of the invasion area, neither outside of it, suggesting that the invasion front has the potential to keep going northwards. Competition by native flora had a significant impact on stress resistance, but did not decrease reproduction or growth. These results are discussed in the light of other ongoing experiments in Belgium.

Keywords: Fitness; invasion range edges; Competition; Stress resistance

Biology and invasion paths of *Ambrosia confertiflora* DC. and *Ambrosia tenuifolia* Spreng. in Israel

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Two perennial species of *Ambrosia* were identified in Israel: *Ambrosia confertiflora* DC., originating from southern US and Mexico, a very aggressive plant, forming large stands reaching more than 3m height, with a very dense subterranean root system, and *Ambrosia tenuifolia* Spreng., native to South America, less aggressive and grows in isolated population. *Ambrosia* spp. invaded through imported feed grains, that spreads along river banks, roadside and railway tracks and by soil movement. Spatial and temporal maps constructed indicate the rapid spread of *A. confertiflora* in Israel.

Both species reproduce from seeds and rhizomes. Seed germination exceeds 50% for both species and is higher during winter, and seedling emergence commences only from the upper soil layers. Vegetative propagation is high; hence attempts to control *Ambrosia* by mowing are inefficient. Preliminary results show in *A. confertiflora* but not in *A. tenuifolia*, enhanced sprouting after mowing indicating apex dominance. The flowering and pollen release season of *A. confertiflora* is between August and December, whereas A. tenuifolia flowers from June to October. However, during the recent years, flowering plants can be found even at midwinter (January/February).

Ambrosia species are wind pollinated, producing large quantities of highly allergenic pollen. Allergy skin tests were performed in two hospitals in Israel, using pollen extracts prepared from pollen collected in the field. Results from 147 volunteers show that 20% of patients reacted at least to one of the species and that *A. confertiflora* is much more allergenic (15 %) than A. tenuifolia (5 %).

Clearly, the rapid growth and spread of *Ambrosia* species in Israel poses a threat to agricultural crops and public health, and should be treated accordingly.

Keywords: *Ambrosia tenuifolia*; *Ambrosia confertiflora*; Maps; Vegetative propagation; Allergy skin tests

Ragweed pollination in France

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With records covering more than 25 years pollen data, RNSA (The French aerobiology network) follows the evolution of common ragweed (*Ambrosia artemisiifolia* L.) pollination: annual pollen index, start and length of the season, new areas with ragweed pollens.

Pollen exposure measurements are based on data from Hirst-type spore traps and correspond to daily pollen concentrations. The data are recorded on a 2-hourly time step, which allows to determine the circadian rhythm of the plant and to evaluate if the pollen is of local origin or transported over longer distance by the wind. In Lyon, the start date of pollination tends to be earlier: the tendency shows that the first pollens arrive one week earlier than 25 years ago. Over the same period, the annual pollen index increased in most of the French pollen stations (even if 2013 was an exception). Circadian rhythm allows studying the evolution of the presence of the plant in a same region: in Auvergne, the North is already infested (pollens in the morning) while the South is not yet infested (a few pollens in the afternoon). And now, ragweed pollens are also recorded in the West of the country, while this was not the case before.

Twenty-five years of pollen data history offers an interesting overview of the evolution of ragweed pollination in France: the season begins earlier, the amount of pollen is increasing in most of the stations and it seems that more and more areas are infested and, consequently, more and more people become sensitive and symptomatic.

Keywords: Annual pollen index; Ragweed pollination

Common ragweed (*Ambrosia artemisiifolia* L.): Is the allergenicity of the pollen altered by climate change and air pollution?

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Pollen of the common ragweed is a main cause of allergenic diseases in Northern America, and the weed has become spreading as a neophyte in Europe. It is hypothesized that climate change and air pollution will affect the allergenic potential of pollen, either by a changed pollen season, by a changed pollen amount, by changes of the surface exine or by directly increasing the allergenic transcripts/proteins and interactions with biologically important ligands, e.g., flavonoids.

To better understand the molecular mechanisms under global change scenarios, we carried out a systems biology approach of ragweed pollen upon elevated O3/CO2/NO2 and drought stress.

Scanning-electron-microscopy showed no difference in the pollen size, shape and surface structure under the above mentioned scenarios, whereas individual flavonoid metabolites were increased upon elevated CO2 and drought stress. Transcriptomic analyses showed changes in ESTs, including allergen-encoding ESTs upon elevated O3/CO2 and drought stress. Increased amounts of allergenic proteins were found upon NO2-treatment, in addition nitrosylation of Amb a isoforms were observed that may influence the allergenic potential. CO2-treated pollen or drought stress lead to higher IgE-levels in B cells of mice, and showed even an additive effect, indicating an impact on allergic diseases.

Keywords: Allergenic disease; Climate change; Air pollution; CO_2; Drought stress

The risk of exposure to airborne *Ambrosia* pollen from local and distant sources – an example from Denmark

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Ambrosia artemisiifolia L. is a noxious invasive alien species in Europe. It is an important aeroallergen and millions of people are exposed to its pollen. Objective: To show that atmospheric concentrations of *Ambrosia* pollen recorded in Denmark can be derived from local or more distant sources. Methods: Using a combination of pollen measurements, air mass trajectory calculations using the HYPLIT model and mapping all known *Ambrosia* locations in Denmark.

The annual pollen index recorded in Copenhagen during a 15-year period varied from a few pollen grains to more than 100. Since 2005, small quantities of *Ambrosia* pollen have been observed in the air every year. Through a combination of Lagrangian back-trajectory calculations and atmospheric pollen measurements, we demonstrated that pollen arrived in Denmark via long-distance transport from centres of *Ambrosia* infestations such as the Pannonian Plain and Ukraine. Combining observations with results from a local scale dispersion model show that it is possible that *Ambrosia* pollen could be derived from local sources identified within Denmark.

The high allergenic capacity of *Ambrosia* pollen means that only small amounts of pollen are relevant for allergy sufferers, and just a few plants will be sufficient to produce enough pollen to affect pollen allergy sufferers within a short distance from the source. It is necessary to adopt control measures to restrict *Ambrosia* numbers. Recommendations for the removal of all *Ambrosia* plants can effectively reduce the amount of local pollen, as long as the population is small.

Keywords: Aeroallergen; Pollen measurements; Dispersion model

SESSION 5

COMMON RAGWEED: TOWARDS SUSTAINABLE MANAGEMENT SOLUTIONS FOR EUROPE

Posters

Seed bank and germination of Ragweed seed - *Ambrosia artemisiifolia* L.

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During 2012, at ruderal sites on the territory of AP Vojvodina, on which in previous years presence of *Ambrosia artemisiifolia* L. was established, soil sampling was performed with the aim of seed bank determination. Each sample was sieved through the system of copper sieves of various diameters, according to the method of Conn (1987). After separation from samples, seeds were identified (Skender et al, 1998; Kronaveter and Boža, 1994). At sites with distinct light and sandy soil, significant presence of seeds was established, as well as at the sites on which in several previous years were carried out construction works.

This study also examined germination rate of the seeds of *A. artemisiifolia* in relation to the temperature of their storage. The seeds were collected in 2012 and 2013 from a large number of plants in studied locations. The collected seeds were placed in different environmental conditions with different temperature fluctuations. The results indicate that there is a statistical significance in the germination rate: seeds vernalized at -8 °C showed the highest germination rate in comparison to the seeds vernalized at 4°C and the ones stored at room temperature.

Keywords: Seed bank; Germination rate

New polymorphic markers for genetic diversity studies in an invasive plant: the common ragweed (*Ambrosia artemisiifolia* L.)

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Common ragweed is an annual herb that belongs to the Asteraceae family. It is known as an invasive plant originating from the USA. In France the common ragweed is especially abundant in the Rhône-Alpes basin and currently spreads northwards in Burgundy. Ragweed colonizes different types of environments, such as railways, river sides, wastelands, farmlands and cultivated crops (especially sunflowers crops). Herbicide resistance to linuron, glyphosate and/or acetolactate synthase inhibitors has been reported in the USA, which complicates the chemical control of ragweed. In addition, the highly allergenic pollen of ragweed causes severe allergies. These elements make this plant a major threat to health and to the environment in Europe.

To investigate the genetic diversity and the patterns of gene flow in *A. artemisiifolia,* reliable, polymorphic molecular markers are requested. Until now, only a handful of microsatellites markers are available for this species. We used an enriched microsatellite library coupled with 454 next-generation sequencing to develop a new set of microsatellite markers. The new set of markers and pre-existing markers have been thoroughly tested for stable PCR amplification and reliable genotype scoring. The presence of null alleles has been checked. Here, we present genetic diversity data obtained for twelve ragweed populations, sampled across the core area of presence of the species (Rhône – Alpes basin) and its northwards limits (Jura and Burgundy).

Keywords: Herbicide resistance; Chemical control; Genetic diversity; Gene flow; Polymorphic molecular markers

Impact of campaigns to control common ragweed on the pollen production in France

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The dispersion of common ragweed (*Ambrosia artemisiifolia* L.) is anthropogenic, and because it is an invasive plant, a number of control procedures have been implemented whose effectiveness was measured. Measures on pollen emissions were compared between areas with different level of management. In addition to pollen traps of the French aerobiology network (RNSA), passive traps (SLT: SIGMA2 Like Trap) were positioned near controlled or non-controlled areas.

Two areas were selected:

- infested areas, in Rhône-Valley, 12 SLT were set up: 8 in Estrablin, with 2 in non-controlled areas and 6 in well-controlled areas; 4 near Valence, with one in non-controlled area and 3 in well controlled areas
- a few infested area around Dijon with 4 traps located in lightly infested areas of which one in an area without ragweed plants and three in areas with presence of small amounts of ragweed plants.

Ragweed pollen amounts collected from controlled and non-controlled areas are different, with a difference of ten to hundred times of the number of grains for controlled against non-treated areas. On the area not really infested, the quantities of pollen are limited to low tens of ragweed pollens grains. Periods of heavy pollination of ragweed pollens are similar for SLT and Hirst pollen traps. Even if the amounts of pollen collected from the well-controlled infested areas are still high, they are significantly less important than the amounts present on non-controlled areas.

The set-up of management practices enables to locally reduce the pollen pressure but only a generalized and integrated control will actually enable to relieve allergy threats to people.

Keywords: Management effectiveness; Pollen amounts

The allergenic invasive plant *Ambrosia artemisiifolia* L.: a new research platform in Poland

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The spread status of *Ambrosia artemisiifolia* L. in Poland is still an open problem. The aim of the study was to build a research platform for monitoring the current state of research on *A. artemisiifolia* allowing the analysis of its present distribution, seed germination, genetic and cytogenetic diversity, the influx of ragweed pollen from neighboring countries and the estimation of the threat of ragweed allergens in the Polish population. Our results show that in recent years, a rapid increase in number of new stands has been already recorded. Results on the biology of sexual reproduction showed that *A. artemisiifolia* produces viable seeds and that seed stratification is necessary to increase the ability to germinate and tolerate salinity. Genetic studies revealed high level of polymorphism among individuals in *A. artemisiifolia* populations, which might be the result of multiple sources of introduction and is possibly crucial in their invasive success. Within the chromosome complement of *A. artemisiifolia*, physical mapping of 5S and 18S–5.8S–25S rDNA loci provided markers for 6 out of 36 chromosomes. Comparative analysis of karyotype structure in populations of *A. artemisiifolia* in their introduced and native range is still required and will be implemented. The preliminary back-trajectory analysis of air masses moving to Poland reported the influx of *Ambrosia* pollen from the southern direction, probably from Slovakia, Hungary and Ukraine. The raising tendency in sensitization to ragweed pollen is still observed, but the estimation of the real threat needs the complex allergological diagnostics in patients with inhalant allergy symptoms.

Keywords: Monitoring; Distribution; Poland; Genetic diversity; Ragweed pollen

Microbial herbicides as control agents against common ragweed

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Common ragweed (*Ambrosia artemisiifolia* L.) is rapidly spreading in Europe and is naturalized in many areas mainly through contaminated sunflower- and bird seeds. This noxious weed produces pollen, which is highly allergenic and can cause late-summer allergenic rhinitis and seasonal asthma. Effective agents to control this weed of the *Asteraceae* family are limited and use of chemical herbicides is becoming an environmental concern.

Novel approaches for more environmental friendly and effective agents to combat this weed are demanded. Application of plant-associated bacteria as bioherbicides could be a successful strategy to win the battle against the invasive common ragweed. Such bacteria could either be rhizobacteria or endophytes, which are in close relationship with ragweed. Because of their selectiveness of association with the host plant, such bacteria can be applied on agriculture land, without harming the crops. Another aspect of using natural occurring bacteria is the low risk of becoming an enemy, like for insects.

In the frame of a research project we are looking for rhizobacteria and endophytes from ragweed, which can reduce germination, growth and pollen production. Therefore we collected ragweed from different sites in Austria and isolated around thousand bacterial isolates. To test them of bioherbicidal effects, several screens will be carried out, like production of hydrogen cyanide, indole acetic acid and toxin production. Positive bacterial strains will be tested on ragweed for the ability to reduce the growth of ragweed.

Keywords: Bioherbicides; Sustainable management; Rhizobacteria; Endophytes

Cross-reactivity of *Ambrosia artemisiifolia* L. with other plants: could rare European *Ambrosia* species create an increase of the prevalence of allergic diseases in the future?

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In France, *A. artemisiifolia* L. (*Aa)* covers fields in the mid Rhône Valley. Rare identified species are: *Ambrosia trifida* L. *(At)* -South-West crops-, *A. psilostachya* DC. (*Ap*) -some areas (Camargue)-, *A. tenuifolia* Sprengel (*Ate*) -Porquerolles island-, *A. maritima* (*Am*), the only European native Ambrosia species, -marine sands of the Mediterranean-.

Numerous factors are responsible of an increase on health impact of these rare species in Europe, one of them is allergen cross-reactivity of ragweed-related species with other plants.

Allergens are in flowers, airborne-particles, roots, leaves, stems, seeds.

Review: 50 allergens are identified for ragweed-related species (without counting epitope), 40 for mugwort-related species, among them profilins that cause the pollen-food syndrome and play a role in the cross-reactivity between allergens from unrelated sources. Some allergens identified in *Aa*, *Ap, At,* present concomitant sensitizations and clinical cross-reactivities. *Am* also produces sensitization (Waisel). For *Ate,* there is no reference. Amb a 1 has homologies with Cry j 1 (major allergen of *Cryptomeria japonica* Don) that has Cupressaceae cross-reactivity.

Every people does not answer to every allergen, so they are classified in major and minor ones: Amb a 1 is a major allergen, recognized by about 90% of the *Ambrosia* patients, Art v 1, Art v 6, major allergens of mugwort are identified in ragweed. As *Artemisia* species, largely found in Europe since the tertiary era, are a frequent cause of pollinosis, a spread of rare *Ambrosia* would increase the prevalence of allergic diseases.

Therefore, prevention of the spread of these rare *Ambrosia* species seems necessary.

Keywords: Health impact; Allergen croos-reactivity; Profilins; Amb a 1

Growth and development of *Ambrosia artemisiifolia* L. under different trophic conditions

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Ambrosia artemisiifolia L. (common ragweed) is an annual weed regarded as an invasive plant in France. This species can be found in a large range of soil types with regard to texture, pH or nutrient contents. Furthermore, its tolerance to different forms of stress increases its spread potential. This work was undertaken to evaluate the development and growth of common ragweed under different trophic conditions in a common garden. Three cohorts of 15 plants per treatments were sown in spring 2013 and the effects of nitrogen and irrigation were compared on each sowing dates. During the first weeks, vegetative appearance is strongly linked with the sum of temperature. For the first cohort, the effect of the competition induced by two types of plant cover was also studied. It appears that effects of abiotic factors are different according to the sowing dates. No effect was observed for the first cohort when a better growth is observed in higher trophic conditions for the later sowing dates. In our growth conditions, no differences were observed in flowering dates (male and female flowers). Competition of plant cover strongly reduces the growth of common ragweed plants, but was not sufficient to prevent the flowering stage.

Keywords: Growth; Nitrogen; Irrigation; Sowing dates; Plant cover

Seedling growth and distribution of *Ambrosia artemisiifolia* L. in the Czech Republic

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Ambrosia artemisiifolia L.*,* an annual plant native to North America, was accidentally introduced to Europe in the 19th century. Because of its negative impact on human health, agriculture and biological diversity it is nowadays considered as one of the most dangerous European weeds. From the Czech Republic it has been known since 1883, up to the 1990s recorded in about 80 localities, mostly in the warmest parts of the country. Further spread of this thermophilous species is highly likely, supported by ongoing climatic changes and increasing propagule pressure due to the rapid increase in abundance of the species in a wider area of central Europe. As an annual *A. artemisiifolia* is crucially dependent on the successful performance of the juveniles. Seedling growth and development are influenced by temperature and nutrient levels. The thermal window ranges from 10 to 34^{o}C, with the seedling growth being faster under higher temperatures. Despite a continual increase in seedling height, decreased biomass was recorded under the highest temperature. Under low nutrients the seedlings grow more slowly and biomass allocation into the roots increases. The updated distribution of the species in the Czech Republic will be presented in relation to the spring temperatures and soil quality.

Keywords: Establishment; Temperature; Nutrient level; Soil quality

Efficacy of single and combined herbicide treatments on common ragweed at different phenological stages

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Small plot experiments were set up under field conditions in order to evaluate the efficacy of different herbicides and their combinations on ragweed (BBCH: 09-19). Pre-emergence (PRE), post-emergence (POST) and combined (PRE+POST) treatments were applied.

Weed control efficacy was evaluated 3 and 12 weeks after treatments (WAT).

Most important conclusions: due to the lack of precipitation, soil herbicides (pre-emergence treatments) did not work well. Efficacy of ALS inhibitors was good until max. 4 leaf phenological stage of ragweed (BBCH:14). Non-selective herbicides were efficient for older ragweed control also, but ineffective for lately-emerged seedlings (they did not ”meet” with the plant). Due to the selection pressure of hormone type herbicides, monocot species were dominant. Majority of leaf herbicides had no long-term effect; lately-emerged ragweed plants (the ones that emerged after the post-emergence treatments) escaped from the effect of herbicides. Generally, combined herbicide treatments gave better results, than pre-emergence and/or post-emergence ones alone.

Keywords: Herbicides; Control efficacity; Phenology

Recommendations to fight ragweed derived from the EU-project HALT AMBROSIA

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The invasive alien plant *Ambrosia artemisiifolia* L. conquered most of Europe during the past 150 years causing severe health problems by their allergic pollen as well as losses in agricultural yield and biodiversity. The EU-funded research project HALT-AMBROSIA (DG Environment: 07.0322/2010/58340/SUB/B2) was conducted by partners from Austria, Denmark, Germany, Hungary and Slovenia and finished in February 2014 providing several new facts to improve the fight against ragweed.

Research within the main tasks 'Biological fundamentals', 'Non-chemical and integrated control strategies', 'Best use of herbicides' and 'Impact on non-target species and biodiversity' gave valuable input to strengthen and clarify the management strategy that should be followed at the European level.

We recommend the following adaptive strategies for specific infestation levels in European regions:

- Preventing the spread and establishment of ragweed is the first choice of measures to be applied in countries that have no naturalized populations of ragweed. Furthermore, prohibiting further range expansion is also relevant for already invaded countries.
- Reducing the risk of establishment and naturalization by early detection and eradication is very important in regions near to the edge of the actual distribution.
- Controlling already existing populations aiming at minimizing their seed production is relevant mostly to countries with established populations.
- Finally, avoiding secondary dispersal of ragweed seeds by inadequate disposal of plant material from control activities.

The selection and intensity of the provided control options can be adapted to different scenarios like varying infestation levels in given countries, legal regulations of herbicide use, environmental concerns, etc.

Keywords: HALT-AMBROSIA; Control options; Adaptative management strategies

Seed survival and germinability of *Ambrosia artemisiifolia* L. seed samples from Europe

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Ambrosia artemisiifolia L. invaded into Europe by traded crop seed. Seed biology of this annual invasive weed is documented to be rather complicated because of dormancy. The fate of seeds in natural sites of North America might differ to that of seeds from European habitats that comprise different predators and environmental stressors.

Several Central and Eastern European seed populations were sampled and stored at dry or wet, and deep or room temperatures, respectively, by the Austrian and Hungarian teams of the EU-project HALT AMBROSIA (DG Environment: 07.0322/2010/58340/SUB/B2). Tests on germinability (15°C/16 h and 30°C/8 h) and viability (TTC) were performed on seed lots of different ages. Additionally, buried seeds and seeds from soil seedbanks of different seasons were tested for seed survival.

Under field soil conditions, ragweed seed loss between seed disposal in autumn (October) and start of the germination phase in spring (March) was on average 20%.

Seeds stored in the lab at various conditions lost viability by 10-50% within one year.

Viability of seeds stored at dry conditions (room temperature) decreased slowly within three years by 67-90% (mean: 74%). Seeds stored cool (4°C) and dark germinated at rates of 28-62% after four years.

Our observations show that seed viability varies highly depending on the conditions for sampling and storage. Consequently, experiments using seeds from any source should be based on standardized protocols for sampling, storage and manipulation/transportation of seeds. Furthermore, soil seedbank of ragweed proved to be the only plausible test for efficacy and sustainability of any control measure in naturalized populations.

Keywords: Seed dormancy; Seed viability; Soil seedbank

Population Genetics on *Ambrosia* genus: Past, present and future

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A new Task Force within the COST-SMARTER has recently been created. This group is composed of population genetics experts from five European countries in charge of focusing on "Genetics on *Ambrosia*" (Austria, France, Germany, Hungary, Sweden). Their mission was to review molecular methods used in published genetics studies on common ragweed and to discuss about future projects.

Two different types of molecular markers are generally used in the literature to investigate the genetic structure within and between introduced and/or native populations of common ragweed: microsatellite markers and amplified fragment length polymorphism (AFLP). These methods permit the researchers to trace-back the common ragweed invasion history and its worldwide spread as well as to identify certain evolutionary processes like selection, adaptation or genetic bottleneck due to introduction. One common conclusion is the presence of two main genetic clusters within Europe coming from two different regions of the native range. However, this conclusion is based on a limited number of microsatellite markers used (12 nuclear + 4 plastid). New methods using haplotype analysis or selected markers present on functional parts of the genome (i.e., related to herbicide-resistance) should be more investigated in order to increase the knowledge on common ragweed. Transcriptomic analyses are starting to be employed in USA to observe gene expression related to adaptations and identify the genes of the "invasiveness".

These new methods will now be promoted within the different European projects in order to open the way of whole-genome sequencing of Ambrosia artemisiifolia in the future.

Keywords: Population genetics; Microsatellite markers; AFLP; Haplotype analysis; Transcriptomic analyses

SESSION 6

HUMAN PERCEPTIONS OF BIOLOGICAL INVASIONS

Session Chair: Sarah Brunel & Hélia Marchante

SESSION 6

HUMAN PERCEPTIONS OF BIOLOGICAL INVASIONS

Oral presentations

KEYNOTE

Voluntary Codes of Conduct for botanic gardens and the horticultural trade to combat threats from invasive species

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The world's botanic gardens and the horticultural trade between them have been responsible directly or indirectly for the introduction into cultivation of tens of thousands of species. While the vast majority of these introductions have been beneficial, some of them have shown characteristics that make them invasive in some regions and put native vegetation and species at risk. The invasive pathways involved will be discussed.

Examples will be given of known introductions of invasive alien species through botanic gardens in the past and in more recent times and an assessment made of the extent to which the risk they pose may be under-reported.

Amongst the tools that can be deployed to counter such threats are Voluntary Codes of Conduct and such codes have been prepared recently for both the horticultural trade and botanic gardens in various parts of the world. The nature of these codes, methods of implementing them and their successes and failures will be explored. Other market-based instruments such as annual license fees or taxes on the importation of non-native species will also be considered.

The importance of making the staff of botanic gardens and garden centres and the public who visit them aware of the issues will be stressed and examples given of innovative ways in which the messages are being got across.

Developments such as the increasing use of green roofs, living walls and xeriscaping that may pose new threats by introducing potentially invasive species that are pre-adapted to climatic warming will be discussed.

Keywords: Botanic gardens; Horticultural trade; Codes of conduct; Invasive species

Prioritization in invasive alien plant management. How do you link the science to policy

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Prioritization is an important component of tackling threatening processes like the impacts of invasive plants. It needs to be applied to deciding which species, and invasion pathways are most likely to lead to impacts, which of a number of management options are likely to be most effective and it needs to be applied at a policy level to understand and incorporate different public perceptions and values of what the biggest issues/threats are in order to decide what society should do. It is much more than risk assessment. Prioritization is therefore both a science-based and a societal tool for understanding where response should be applied. In this paper we will explore what prioritization is in the context of the management of invasive alien plants, how it is used by both scientists and society in decision making and how it can be optimised to provide the most evidence based and objective outcomes. Why is this important? One example is the Convention on Biological Diversity Aichi target 9 that all signatory countries must enact by 2020. This target calls for the prioritization of pathways and invasive alien species based on their likely “impacts”. But what this exactly means is still being understood. We will try and clarify some of that understanding.

Keywords: Prioritization; Impacts; Public perceptions; Policy

How to communicate on pests and invasive alien plants? The experience from the European and Mediterranean Plant Protection Organization

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Despite the wealth of initiatives on pests and invasive alien plants in European and Mediterranean countries, stakeholders and the general public are rarely aware of what pests and invasive alien plants are and of the damage they cause. Raising the level of awareness of the civil society is an indispensable step for political decisions and legislation to be taken as well as influencing personal action.

The European and Mediterranean Plant Protection Organization (EPPO), in partnership with the Council of Europe and the IUCN ISSG organized a workshop to gather experiences of communication actions. This workshop was entitled 'How to communicate on pests and invasive alien plants?', and was held in Portugal on 2013-10-08/10 (see http://archives.eppo.int/MEETINGS/2013_conferences/communication_pt.htm) and gathered more than 65 participants from 25 countries. The workshop highlighted the wide array of experiences on this issue.

The participants of this workshop recognized the importance of communication actions in tackling pests and invasive alien plants, and the need for further collaboration within the different sectors (e.g. plant health, the environment, the nursery industry) as well as to develop interdisciplinary approaches involving social sciences.

In order to provide assistance to its member countries to communicate this issue, EPPO released a poster aiming to raise awareness of the risks associated with moving plants during international travel, and this poster should be placed in countries' airports (see http://www.eppo.int/News&Events/eppo_poster.html). EPPO also plans to provide communication material on the emerging invasive alien plant *Parthenium hysterophorus* L. (http://www.eppo.int/QUARANTINE/Alert_List/invasive_plants/Parthenium_hysterophorus.htm). Projects are also underway to enhance capacity building on media training.

Keywords: Communication; General public; Political decisions; *Parthenium hysterophorus*

Japanese knotweed versus the general public: the battle royale

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Japanese knotweed (*Fallopia japonica*) is now a well-known and well feared invasive weed at least in the United Kingdom, but that was not always the case. This paper reviews the history of the public perception of knotweed from its arrival as a prize-winning newcomer to the horticultural scene to the most hated plant in Britain and one of the top 100 invasive species in the world. This fall from grace happened over a considerable period of time but this may happen for other weeds at a much faster rate with the current expansion of high speed media. Nonetheless, this example provides lessons for us today.

The plant has been the subject of the "Natural Control of Japanese knotweed" programme which was a pioneering one for Europe. The communication goals were not only getting across the message that the plant is a pest that needs management but that a solution could be the introduction of a "beneficial pest" – a difficult sell!

This presentation reviews the experiences of the team including the difficulties encountered with getting these messages across. In truth the job was relatively easy because Japanese knotweed has very few admirers or supporters and it was possible to build consensus that using another non-native species (albeit a specialist beneficial) was and remains a good idea despite this being a difficult novel concept to grasp. The conclusion is drawn that nowadays a research team needs skills far beyond the scientific and the value of media training and a good communications strategy cannot be understated.

Keywords: Public perception; Media; Communication strategy

How to define invasive plant for different sectors? The way to a consensus

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The control of invasive alien plants involves many stakeholders who need to act together to run an efficient management of these species. To be effective, this kind of approach needs that all the stakeholders understand the specific issues for each sector, by using concepts shared by everyone. To facilitate this dialogue, surveys and semi-structured interviews were conducted during 3 years to understand the terminology used by the different sectors involved and to assess what they would expect from consensus lists of invasive plants. Interviews were carried out with 186 professionals and experts from conservation, landscape and horticulture sectors. The analysis of the replies allows to identify areas of convergence and divergence and so, to develop proposals to improve communication. A prioritization method is proposed, based on consensus reached for different criteria (economic importance, benefits provide by the species) taking into account positive and negative impacts of invasive plants.

Keywords: Stakeholders; Terminology; Consensus lists; Communication; Prioritization

Reaching for allies: communicating on invasive species in Portugal

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Invasoras.pt is a science communication project targeting different stakeholders and the general public, aiming to raise awareness about invasive plants in Portugal. Made available in February 2013, it has used online and offline communication strategies to reach a wider audience both through digital multimedia/interactive content and face-to-face workshops. Social media has taken a huge role in reaching new audiences, working as broadcasting hub and promoting interactivity between specialists and engaged persons. One of the core elements of this project is a citizen science platform where users can map invasive plants in Portugal.

After one year of steady growth in website visits, social media connections and real world interactions, the challenge to grow beyond the critical mass of peers and professionals and find allies in the common citizens is still daunting. The team is undertaking a survey regarding best habits and preferences to achieve a more effective level of communication, to attain better results and response actions. What we've learned is that there are many ways to convey the message and some do not work for all audiences.

Keywords: Public awareness; Citizen science; Invasives & media; Evaluation

Human perception and institutional aspects of ragweed control

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Given the harmful features of ragweed for agriculture and public health, programs have been initiated to control it – with limited success. Studies on ragweed control have focused predominantly on the plant's biological properties and economic, agronomic and health impacts. We extend the understanding of the ragweed problem by highlighting (1) a behavioral perspective on how people deal with ragweed and (2) by offering an institutional and political analysis of ragweed control.

In initiatives to control ragweed, calls have been made on farmers, nature managers and citizens to participate in fighting ragweed. However, such actions are only initiated by people when they (1) recognize the plant to be harmful and (2) when they judge to be susceptible of being exposed to the harm. Furthermore, control tendencies will only likely take place when people (3) think that taking action will be effective and (4) when they themselves feel confident to be able to take effective measures.

Also, such an individual-level analysis is most likely to be effective when taking into account the broader institutional and political landscape in which pest control is embedded. The institutional landscape includes the formal and informal 'rules of the game' that influence how pest control is organized at local, country or regional level. The political landscape includes collaborations between multiple stakeholders, their mutual dependencies, power-plays, and the effectiveness of their collaboration in terms of tackling current and future pest problems. An integrated analysis that includes behavioral, institutional and political dimensions of ragweed control can complement existing analyses.

Keywords: Ragweed control; Public perception; Institutional dimension

In the shade of a Farnesian acacia: introduction and diffusion of a Mesoamerican species in Europe

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Acacia farnesiana (= *Vachellia farnesiana*) has been recognized as a new botanical species in 1625, from plants of Mesoamerican origin cultivated in the Roman gardens of the Farnese family. It seems to have been the first New World acacia described in botanical terms in Europe and it might have played a linking role, in conceptual and practical terms, between the "ancient" acacias described by the Classics (namely *Acacia nilotica* and *A. seyal*, currently ascribed to the genus *Vachellia*) and the "modern" acacias of Australian origin, introduced in Europe since the late 18th century.

During the 16th century, some sources suggest that this Mesoamerican acacia was not yet differentiated from Egyptian and Near East acacias, familiar to European scholars through contacts with the Islamic culture, and descriptions included in late Medieval codices and Renaissance books. By that time, seeds of the would-be *Acacia farnesiana* were being transferred from its native range in Mexico and the Antilles to Europe, Asia and Africa, along with other "new" plant species. Its early introduction in several locations can possibly be regarded as one of the markers of the first regular network of transoceanic routes circuiting the globe, in the second half of the 16th century, having reached Australia before the English settlement of the 18th century. Currently, it is considered one of the most widespread species of *Acacia* (*sensu lato*) and, in some specific situations, also involved in invasive processes, namely in the Canary Islands and the Philippines.

Along with the role played by *A. farnesiana* in making the connection between ancient and modern acacias, this presentation will focus on the geographical diffusion of this species in SW Europe, from Portugal to Italy, exploring its current perception and representation.

Keywords: *Acacia farnesiana*; Farnese gardens; Introduction of exotic species; Historical geography

SESSION 6

HUMAN PERCEPTIONS OF BIOLOGICAL INVASIONS

Posters

Towards a strategy on invasive species in Provence-Alpes-Côte d'Azur region (France)

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In France, a regional strategy on invasive species in Provence-Alpes-Côte d'Azur (PACA) region is carried out by two National Botanical Conservatoires (CBN Alpin and CBN Méditerranéen de Porquerolles) at the initiative of the Minister of the Environment (DREAL PACA) with the financial support of the PACA Region. Planned for two years (2013 – 2014), its originality lies in the fact that it is elaborated with the participation all stakeholders concerned by invasive species. In this way, local context, regional issues and stakeholders' expectations will be considered into the regional strategy, in line with the guidelines of the national strategy for biodiversity 2010-2020.

During last year, lists of invasive or potentially invasive species in PACA have been elaborated at different scales (administrative and biogeographical scales). These lists are intended to be used for the management of natural areas. A regional survey of different professional sector (environment, agriculture, horticulture, forestry) has also been carried out, with the aims to identify: (i) all stakeholders in the project area, (ii) their perception of invasive species, (iii) their expectations and (iv) the elaboration of a regional assessment of actions concerning invasive species. A Technical Committee composed of professional representatives is set up to give an advisory opinion on methodological and technical guidelines for the project. Three territorial workshops will be held in 2014. Further expectations, local specificities, aims and actions of the strategy, the level of involvement of each stakeholder, opportunities for collaboration and funding possibilities will be listed during these workshops to formulate a regional strategy and an actions plan. A restitution seminar will be provided at the end of this program.

Keywords: Regional strategy; Invasive species lists; Stakeholders' perception

Using the invasive plant *Dichrostachys cinerea* L. as an energy crop in Cuba: An elegant way to encourage farmers to mechanically control it

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The Marabou weed (*Dichrostachys cinerea* L. Wight & Arn.), a woody shrub introduced in Cuba during the 19th century, has become an invasive species difficult to control. Currently, it grows on more than 1.25 Million ha (i.e. 20% of the Cuban arable land) or 12% of the national territory. It has great potential as an energy crop because it is a perennial crop that does not require annual reseeding and many agricultural inputs. Taking into account an approximate yield of more than 30 t ha^{-1}, an estimated of more than 35 Mt of biomass could be produced. The wood and pellet physicochemical properties were assessed and compared to other woody species used for energy crops. Its good chemical composition (46.5% C, 6.2% H, 0.7% N, 0.04% Cl, 0.08% S, 40% cellulose, 21% hemicellulose, 30% lignin), its high wood density (0.83 g cm^{-3}) and its fuel properties (4509 kcal kg^{-1} high heat value, 2.9% ash content) allow industrial, and probably domestic, energy use. The wood pellets had good standard properties (690 kg m^{-3} bulk density, 4.2% moisture, 0.1% amount of fines). However, the mechanical durability (93.9%) was slightly below the minimum value required for non-industrial use. So, the addition of a binding agent (e.g. 1-2% potato flour) during the production process should be assessed for improving it. The energy use of Marabou could encourage the bushwood harvesting as mechanical control, but a better understanding of the impact on the soil should be necessary to guarantee the sustainability of the agro-forestry systems.

Keywords: Solid biofuel; Pellets; Invasive plant; Sustainable management

SESSION 7

NEW TOOLS FOR WEED RISK ASSESSMENT (WRA) AND FOR EARLY DETECTION AND RAPID RESPONSES (EDRR)

Session Chair: Andy Sheppard, Giuseppe Brundu & Isabelle Mandon-Dalger

SESSION 7

NEW TOOLS FOR WEED RISK ASSESSMENT (WRA) AND FOR EARLY DETECTION AND RAPID RESPONSES (EDRR)

Oral presentations

KEYNOTE

Weed eradication: feasibility and programme evaluation

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Eradication is an attractive management option for newly invading and potentially serious weeds. Given success, eradication is generally the most cost-effective management strategy. However, it is usually costly and may require a substantial 'up front' investment. For these reasons it is important to determine how difficult (expensive) eradication may be before committing to such an undertaking. In this talk I will outline an approach to the assessment of eradication feasibility, illustrating this with species comprising a variety of life forms and histories.

Once committed to eradication, it is essential to determine on a regular basis whether the goal of eradication is being approached (and at what rate) since, in the absence of rigorous evaluation, a programme may easily evolve into an open-ended control effort. Two methods for assessing progress towards eradication are presented, with models parameterised using data from recent Australian programmes targeting branched broomrape (*Phelipanche mutellii*) and chromolaena (*Chromolaena odorata*) in South Australia and far north Queensland, respectively.

Harmonia^{+}: a rapid risk-screening procedure for alien species

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Before prevention or early eradication of invasive plants can take place, it is essential to first identify those species that pose the highest risks. Given the huge and still-increasing number of species that become transported, such a prioritization must allow for a high number of species to be assessed in a relatively short time.

For Belgium, Branquart (2007) launched a scheme that allowed to quickly screen the spread capacity of species and their environmental impacts (ISEIA protocol). Yet, during the years, this scheme was found to unsatisfactorily cover several issues, and the challenge was therefore to refine this scheme further yet retain its simplicity.

We therefore constructed a rapid risk-screening procedure named *Harmonia*$^{+}$. The protocol assembles 30 key questions on a particular species, the answers to which need to be provided by one or more experts. The questions refer to the species' risks for (1) introduction, (2) establishment, (3) spread and (4) impacts, the latter of which are subdivided into impacts on (4a) environmental, (4b) plant, (4c) animal and (4d) human health. The answers are ordinally scaled, and this allows to put these risks into scores, and thus, to rank and prioritize species.

Harmonia^{+} has come about through the collaboration of eight Belgian scientific institutes. Two panels of (inter)national experts provided comments and input, one panel of which completed an anonymous survey, and deemed the protocol to be clear, consistent, complete and useful.

Harmonia^{+} can be consulted at http://ias.biodiversity.be/harmoniaplus.

Keywords: Prioritization; Belgium; Risk-screening tool

Predicting the invasion potential of alien plant species in Portugal using the Australian Weed Risk Assessment

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It is well recognized that invasion by alien plants has serious adverse impacts on biodiversity and ecosystem services, as well as other economic and social impacts. However, predicting which plant species will become invasive remains a great challenge. Many countries in the world have already adopted a Weed Risk Assessment (WRA) scheme with the purpose to identify potential invasive plant species, prevent their spread and reduce their damaging effects. One of the most well-developed and successful predictive scheme is the Australian WRA that has shown to perform consistently across varied geographies and climates.

In this study, we investigated the effectiveness of adapting the Australian WRA scheme to the Portuguese conditions. Our aim was to evaluate the reliability of this scheme to predict invasiveness of alien flora in Portugal and propose adaptations to turn it more fit to local conditions. To achieve this, two sets of plant species were analyzed: one set included all plant species considered invasive by the Portuguese legislation (i.e., Decreto-Lei nº 565/99 of 21 December 1999, which lists invasive species based on expert opinion) while the other set included a number of randomly selected alien (not invasive) plant species that are known to occur in the country. The results obtained will be discussed emphasizing their usefulness in preventing the spread of potentially invasive plants and for setting management priorities.

Keywords: Weed Risk Assessment; Invasive plant species lists in legislation; Naturalized and casual species

The Implemetation of the Prioritization Process for Invasive Alien Plants in the Balkan Countries

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Area of the Balkan peninsula - Bosnia and Herzegovina, Bulgaria, Croatia, FYR Macedonia, Montenegro, Romania and Serbia characterized by a highly diverse flora and significant level of plant endemism, agriculture and tourism are very important,and because of that the problem of invasive alien plants is potentially a highly significant one and the system of dealing with it requires radical improvement. Bearing this in mind, it is necessary for these countries to become actively involved in the work of the EPPO (European and Mediterranean Plant Protection Organization) Panel on Invasive Alien Plants.

In order to make the first steps in forming a strategy for the Balkans, current national invasive alien plant lists were considered. This showed that the problem of creating these lists is very complex and in forming them, researchers have often followed their personal opinions, without a unified and predefined criteria defining invisibility, it only emphasized the significance of the Prioritization process for invasive alien plants. Its application would enable a data exchange and harmonization of results for different countries, thus facilitating the standardization of the entire process. The application of this process for the area of Balkans was performed by researchers from this region, and it involved 12 potentially invasive plant species, in the end giving us the seemingly simple answer on the invasibility of the chosen species. Even though this was just a foundation for further work, the application of the Prioritization process for invasive alien species as a standardized procedure proved it to be highly significant in practice.

Keywords: EPPO prioritization process; Balkan Peninsula; Invasive alien plant lists

Assessing the invasiveness of plant species from China

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Invasive plants in crops and pastures cost an estimated 2.2 billion dollars annually in Canada due to damage and weed control. The potential of contamination by invasive plant species may affect Canadian agricultural and ecological systems. Agricultural importation from China to Canada has increased rapidly in recent years. However, little is known about ecological and biological characteristics of these Chinese plant species. The main objective of this project is to determine the invasive potential of plant species from China growing in regions that are climatically similar to Canadian Prairie provinces.

Seeds of 169 plant species were collected from China. Fifty-seven species that are not currently found in Canada were evaluated using a modified Weed Risk Assessment (WRA) model. Fifty-four species were confirmed to be invasive, and the remaining three species require future evaluation.

The top 20 species from the WRA model were tested for germination at five alternating temperature regimes with amplitude of 10 °C in 12h/12h light/darkness to establish the base temperature (Tb) and thermal time (TH) requirements. Six species had significant dormancy, such as Plantago asiatica, Amethystea caerulea, and Turczaninowia fastigiata with the potential to develop persistent soil seed banks. The base temperature (Tb) for germination ranged from -2.4 (Artemisia sieversiana) to 12.4 °C (Chenopodium aristatum) and thermal time (TH) requirements varied greatly among the species tested.

Results from this project provide baseline information about the potential invasiveness of these species in Canada and help with the development of strategies to prevent and control their expansion in Canada.

Keywords: Weed risk assessment; Plant invasion; Base temperature; Thermal time model, Seed dormancy, Canada

Impact of alien plants in Europe on environment and socio-economy: towards a unified system used for prioritization

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Biological invasions cause serious impacts, both environmental and economic. Despite decades of intensive research on individual invasive species and their invasiveness, rigorous studies exploring the impacts of invasive species in Europe have only started to appear in the last decade. Among these, there are several studies focused on quantifying the impacts of alien animals by using the similar impact scoring systems. However, a similar assessment of the impacts of alien plants is still lacking.

We used a scoring system based on 12 categories, six of which refer to environmental and six refer to economic impacts. In each category the species can reach a score, reflecting the level of its impact. The score varies from 0 (no impact) to 5 (highest impact) depending on the magnitude of impacts. All levels of impact within categories are precisely defined and described, thus the scoring is an objective, transparent and repeatable procedure. The scoring system used for plants was unified with previously existing systems developed for animals making it a comprehensive standard tool to translate facts from scientific journals to policymakers and managers. It can also be used as a tool for prioritization of species for management.

We present results from scoring of impact of 128 European alien plants mentioned in DAISIE database. The scoring was done by exploring primary literature such as case studies of impacts of individual species, and other sources. Rankeing species according to impact revealed that *Arundo donax*, *Acacia longifolia* and *Lantana camara* are top invaders in Europe in terms of environmental impacts, while *Abutilon theophrasti*, *Crassula helmsii* and *Elodea canadensis* are top invaders in terms of economic impacts.

Keywords: Impact; Scoring system; Environment; Economy; Management; Prioritization; alien plants; Invasion

Early detection: from the regional to the national level

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Implementing a preventive strategy against invasive plants in France requires improvement of the current system of data sharing. The recent example of early detection of Japanese Knotweed in Corsica has shown that species known to have negative impacts already present on the French territory are easier to detect, and reporting is quicker, than for exotic species not yet known to cause negative impacts. Nonetheless, building an efficient national survey system, as required under new European regulatory project on Invasive Alien Species (IAS), requires reliable, exhaustive, homogeneous and updateable information. An aggregation of the data across French regions led to a map published by the Federation of the National Botanical Conservatories (FCBN). This system, available for consultation on-line, delivers species distribution maps for France (rural and urban districts) based on 10 by 10 km square plots. In order to provide early detection alerts for IAS in France, actions are in progress to improve the way new taxa are registered in the national reference table, to harmonize terminologies and local typologies. Elements that could be useful to register alerts of new incursions are included. As these data come from multiple stakeholders, groups of experts have been setup to validate the data and maps and to make sure the edited information is compatible with existing data and makes sense in relation to the known distribution of the species. Thresholds of species occurrence and sampling issues in relation to the different stages of naturalization are discussed.

Keywords: Invasive plants; Information system; Early detection; Maps; Validation

Warning network and tools for detection of new biological invasions in Reunion Island

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When a potentially invasive species is introduced in a native or non-native habitat, early detection coupled with rapid response (EDRR) can prevent their spread and avoid the high costs related to their eradication. The eradication from an entire territory, is not always possible to achieve but it can also be focused areas of major conservation importance.

From 2003, the National Forest Department of Reunion Island initiated an early detection system of new invasive plants for the State forest. From 2003 to 2010, 383 reports have been recorded, concerning 154 non-native plants. From 2009 to 2013, the National Park recorded about 500 reports concerning more than 80 plant species.

The databases have now been transferred to a new specific database connected to the regional Flora database "Mascarine Cadetiana™", that all conservation officers and natural area managers will be soon be able directly to add information allowing rapid response implementation and the associated actions.

This new database is also accessible through the "Reunion Invasive Species Group" website (GEIR - http://www.especesinvasives.re) where the reporting form can be filled online. Public involvement, however, requires a validation system of any submitted data. A network of experts, for each taxa group (plants, terrestrial vertebrates, invertebrates, aquatic organisms, marine organisms) has been set up to validate such submissions. To engage more people and gain broader public interest, a few selected target species will be presented on the website and classified using the ISEIA protocol, with a maximum of ten target species per category (e.g. tree, shrub,…).

Keywords: Reunion Island; Early detection; Rapid response; Invasive species; Database.

IT&C and citizen science for a better management of weeds in the Western Indian Ocean Region

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Increasing agricultural productivity faces challenges from multiple factors, significant of them being weed infestations. Weeds are responsible for a minimum of 20% loss of harvests in food and cash crops. Efficient control of weeds requires identification, effective control methods, and dissemination of current data to increase awareness among all actors. A collaborative project has been initiated to provide a participatory platform and a range of tools to support these actions.

WIKWIO: Weed Identification and Knowledge in the Western Indian Ocean aims to develop a suite of science-based, computer-driven tools. A combination of applications will be developed:

-The participatory portal from which 1) The public can consult species information, and upload observations; 3) Members can share and manage species data;

-IDAO application which utilises computer-aided plant identification;

This toolkit will facilitate the sharing of information from actors such as scientists, teachers, agronomists, extension staff, field workers and farmers and to disseminate compiled information to stakeholders in charge of the management of weeds.

All tools can be used from the portal (http://portal.wikwio.org).

WIKWIO covers 320 weeds of 14 food or cash crops of the area. Since no single actor or institution can study everything on weeds, the contribution of all to the knowledge of species is essential. By assisting with the identification of weeds and facilitating the sharing of information between interested parties, WIKWIO will promote sustainable agriculture and will contribute to capacity strengthening of local institutions. This project is funded by ACP S&T programme of the European Union.

Keywords: Weed management; Global database; Identification; IDAO; Data sharing; Citizen science; NTIC; Network.

Environmental risk assessment in support to plant health – the experience from EFSA

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The EFSA Plant Health (PLH) Panel started its activity in summer 2006. Its mission is to support European decision-makers with scientific advice on the risk posed by harmful species (including both plant pests and pest plants) which threaten crop production and biodiversity in Europe. In 2011 the PLH Panel developed its own methodology for assessing the environmental risks posed by invasive alien species (IAS) that may enter, establish and spread in the EU as part of the pest risk assessment process (EFSA PLH Panel, 2011). This approach includes both the structural and functional components of the threatened environment: (i) structural components are interpreted in terms of impacts of the IAS on genetic, species and landscape diversity, and (ii) functional components are evaluated by estimating how the IAS modifies ecosystem services throughout the alteration of the functional traits of a given ecosystem. A scenario analysis is required in order to define spatial and temporal resolution of the assessment and characteristics of the considered environment (Gilioli et al., 2014). This theoretical approach appears in line with the proposal for amendment of the EU phytosanitary (plant health) regime published in May 2013, where the relevance of impact on biodiversity and ecosystem services is highlighted (COM/2013/0267). The scheme has been recently tested on an environmental impact for the apple snail *Pomacea* sp (EFSA PLH Panel, 2014) and is under consideration by other EFSA Panels dealing with assessments of environmental impacts produced by different stressors (in particular GMOs and pesticides).

Keywords: Environmental risk; Invasive alien species (IAS); Ecosystem services; Functional and structural biodiversity; Service-providing units

SESSION 7

NEW TOOLS FOR WEED RISK ASSESSMENT (WRA) AND FOR EARLY DETECTION AND RAPID RESPONSES (EDRR)

Posters

New potentially invasive kenophytes in Poland

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The arrival of new alien species in Poland could be commonly observed in recent years. They are mostly found as already established and not in the stage of ephemerophytes (i.e. casual alien). Fifteen species recorded as established in recent years have been chosen for further analysis. Many of them have presently a scattered distribution in Poland, but seem to be expanding in the nearest neighbourhoods. Most of them are cultivated for ornamental purposes. Frequent transitions can be observed from the stage of an ephemerophyte into a kenophyte, accompanied by a rapid proliferation of the species within a wide variety of habitats, including semi-natural and natural ones.

Because of a decreasing number of regional floristic monographies in Poland, the new arrivals of alien species are often reported not before they have begun to spread within native plant communities, e.g. when periodically monitoring protected areas. Such a situation requires both researches on the synanthropic flora covering large areas and a regulation (including trade bans) on the cultivation of those alien species which are invasive in other European countries with a similar climate.

Keywords: New kenophytes; Poland

Ambrosia trifida L. in France: current distribution and ecological knowledge. Towards an eradication of the species?

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Giant ragweed (*Ambrosia trifida* L.) is an annual plant belonging to *Asteraceae*, originating from North America. It was introduced in France in the early twentieth century. Originally described as a ruderal plant, *Ambrosia trifida* was recently reported in agricultural areas (maize and soybean) in the region Midi-Pyrénées. Beyond the potential public health issue, this species is a major invasive weed in North America, its native area.

That is why a question arises about the future trend of the species in France. Can we expect a low ability of the species to adapt the French habitats and land-uses, with a low probability of naturalization? Viceversa, should we consider leading a management program, before it colonizes different habitats where its management would be much more complicated?

Data acquired in 2013 seems to support the hypothesis that giant ragweed eradication in France could be a realistic medium-term objective.

Keywords: Ambrosia trifida; Invasive species; Monitoring programs; Herbarium; pollen; Allergies

DNA barcoding as identification tool for EU regulated plant pests and invasive plants: the preparation and validation of an EPPO standard

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The EUPHRESCO DNA barcoding project aims to collect, harmonize and validate DNA barcode protocols for the identification of EU regulated arthropods, bacteria, fungi, invasive plants, nematodes and phytoplasmas. DNA barcoding is a generic diagnostic method that uses a short standardized genetic marker in an organism's DNA to aid species identification. In case of plant pests and invasive plants one or multiple loci are used for identification. DNA barcoding protocols for arthropods, bacteria, fungi, nematodes and phytoplasmas were developed within the Quarantine organisms Barcoding Of Life (QBOL) project financed by 7th Framework Program of the European Union. After the finalization of the QBOL project, DNA barcoding protocols were made available through the regulated plant pest and invasive plants database Q-bank (www.q-bank.eu). New protocols for bacteria, invasive plants and fungi were added to Q-bank. Within the EUPHRESCO DNA barcoding project, a diagnostic European and Mediterranean Plant Protection Organization (EPPO) standard with the available DNA barcoding protocols will be prepared. DNA barcoding protocols will be optimized and harmonized to make them more user-friendly. Apart from test specific information, guidelines for consensus sequence preparation and output interpretation of database searching will be provided. The usability of the EPPO standard will be determined through an international inter laboratory test performance study (TPS). Diagnostic sensitivity, repeatability and robustness will be determined to demonstrate if the EPPO standard is fit for purpose.

Keywords: Validation; DNA barcoding; Test performance study; Plant pests and invasive plants; EPPO standard

Continuous changing of the botanical garden's native flora through invasion of alien species

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The Main Botanic Garden of the Russian Academy of Sciences was established in the northern part of Moscow in 1945. Between 1945 and 1949 the construction of the territory (garden?) was carried out, but no standard collections were created before 1949. The comparative analysis of the floristic checklists (native species only) of the Main Botanic Garden (Moscow, Russia) of 1949 and 2014 (vascular plants only) was carried out within this research. In 1949 485 species were recorded within the land covered by the garden (360 hectares): 460 native species, 10 species escaped from cultivation, 5 alien species (weeds) and 10 species under cultivation. With the exception of the cultivated species (more than 6, 000 taxa, at the moment), at present the botanic garden's flora comprises 859 species. Most of them (520) are native species and 288 species escaped from cultivation. Fifty alien weeds were detected in the Botanic Garden's territory. Thus, the alien component of the Botanic Garden's flora accounts for 338 taxa, i.e., 23 times more than in1949. A brief synopsis of the alien species is presented. The ranking of the invasive status is provided, according to the categories implemented in the European botanic gardens consortium project "Sharing information and policy on the potentially invasive plants in Botanic Gardens". About one half of the alien weeds, invading botanical garden's territory can be classified as transformers. The first estimation of species' invasive potential is provided with the purpose of preventing the introduction of potentially invasive alien species.

Keywords: Botanic garden; Alien species

Preliminary results of the eradication efforts of alien hogweeds in Estonia

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A noteworthy increase of range invaded by the phototoxic and noxious giant hogweed (*Heracleum mantegazzianum*) and Sosnowsky's hogweed (*Heracleum sosnowskyi*) has occurred since 1960's in Estonia. These alien hogweeds are listed as invasive species likely to disrupt natural balance according to the regulation of the Minister of the Environment of Estonia. Since 2005, systematic eradication, based on the national management plan of alien hogweeds, has been implemented by the Environmental Board of Estonia. Over 99% of the mapped area occupied by alien hogweed colonies is under eradication effort each year. Although so far many of the hogweed colonies can be accounted as removed, at the same time the area invaded by alien hogweeds is continually enlarging (235 ha in 2005, 2,051 ha in 2014). This is probably due not only to the spread of the hogweeds but rather to the increasing public awareness. The annual estimations of the effectiveness of the eradication works have shown that the density of hogweed stands takes at least 4–5 years to decrease significantly. The persistent seed bank (seeds can germinate after 7 years) is a serious hindrance to effective eradication. Therefore, the consistency and soundness of the eradication is the key for success, as one year of renewed seed production gives a setback for several years.

Keywords: Alien hogweeds; Giant hogweed; Sosnowsky's hogweed; Management plan; Effectiveness of eradication effort

Progress towards eradication of an emerging invasive succulent in South Africa

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Furcraea foetida is one of eight Agavaceae species that have naturalized in South Africa. Although present in four provinces, its distribution range is comparatively limited and local Agavaceae experts believe that with sustained effort the species could be eradicated from South Africa. In 2012 the South African National Biodiversity Institute's Invasive Species Programme (SANBI ISP) initiated a large-scale management project on *F. foetida*. More than 18 000 plants were cleared in 50 days by a team of twelve people in KwaZulu-Natal, a province of South Africa, at a cost of R163 000 (~ €10 200). A second clearing effort initiated in early 2014 resulted in 8 000 more plants being cleared to date. Here we report on the SANBI ISP efforts to raise awareness, encourage reporting by local residents in the target areas, build stakeholder collaboration and conduct roadside surveys in hotspot regions, all of which led to a significant increase in detection. The feasibility of eradicating this species from South Africa will be discussed with reference to the data collected so far and the lessons we have learned.

Keywords: Invasive succulent; Agavaceae; Early detection and rapid response


invasive
species
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plants
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Plant
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traits
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Parthenium
assessment
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Israel
Mediterranean
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France
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Algeria
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Solanum
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microbial
soil
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Ailanthus
lobata
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chemical
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Invasion
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Pueraria
America
Ecological
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eradication
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Algeria
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western
impacts
different
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changing
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Acacia
physiological
Biology
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microbial
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lobata
AMBROSIA
ecosystems
invasion
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Region
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ARTEMISIIFOLIA
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Weed
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